INTRODUCING TECHNICAL ENGLISH FOR FUTURE ENGINEERS

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INTRODUCTION

Purpose and Scope of the Course :

Purpose :

The purpose of this course , as its title indicates , is to teach students of the faculties of engineering and institutes of Engineering (including different branches of this field of study and specialization)the basic language of engineering in English . The basic language is made up of sentence patterns , structural /functional words , non- structural vocabulary , which are common to all engineering fields or branches , and form the essential framework upon which the special vocabulary is founded . Once this basic technical vocabulary has been mastered , the acquisition of these special terms and words becomes logical and natural to the learners.

The material presented in this course has been very carefully selected from the scrutiny of a lot of resource books in the field of engineering . The main criterion of selection and inclusion of material here was frequency /range.

Grading and flexibility:

Although it is assumed that students using this course have already received a certain amount of training in English at school or in a language institute , the material included has , in its presentation , been graded in length and complexity . This means that the most frequently used and simple structures have been introduced first . The length of the reading comprehension passages and therefore of the amount they contain , increases progressively.

In addition to the purely language-teaching aims outlined above, the introducing English for Engineers course is designed to stimulate productive thinking and foster the habits of clear exposition and impartial examination of evidence . Also it is meant to encourage prospective engineers to take an active interest in their own field of specialization and its relationships with other branches in the same field, and with the world society at large .

This course embraces a number of complementary parts. Firstly, the reading comprehension passages and dialogues, all geared toward the technical language and vocabularies used in the field of engineering, are presented. They are always headed with a number of technical terms that are used in the passages and dialogues . these are followed by comprehension questions and /or cloze vocabulary exercises and drills .Secondly, there is the special grammar section, which introduces a contain amount of grammatical rules. They are included for students to refer to when the need arises, so as to refresh their memories about them. Also a short story and a literary passage are included so as to give students stations for variety and fun. They are meant to word off any feelings of fatigue fun . they are meant to word off any feelings of fatigue or boredom . it is hoped that students will find the whole course rewarding, fruitful, and beneficiary.

The editor
2007

PART I

COMPREHENSION PASSAGES

UNIT ONE

THE ENGINEERING PROFESSION

Special Terms

Engineering: The application of scientific principles to practical ends. An *engineer* is a member of the engineering profession, though the term also refers to people who operate or maintain certain kinds of equipment - a locomotive engineer on a railroad for example. In the latter use, the person referred to is a highly trained technician rather than a professional engineer.

Empirical Information: Information that is based on observation and experience rather than on theoretical knowledge.

Wedge: A triangular-shaped piece of material with one very acute angle. It is one of the simple basic machines used for tightening or levering.

Inclined Plane: A surface at an angle less than 90° from the horizontal. It is another simple or basic machine used to raise or lower a load by rolling or sliding.

Quantification: Giving numerical values to information.

Mechanical Engineering: The branch of engineering that deals with machines and their uses. *Industrial engineering* is a branch of this field that deals with the use of machines in industrial environments such as factories.

Civil Engineering: The branch of engineering that deals with the design and building of structures intended to be stationary - buildings, dams, and bridges, for example.

Mining and Metallurgy: The branch of engineering that deals with extracting materials from the earth and refining them.

Chemical Engineering: The branch of engineering that deals with processes involving reactions among the elements, the basic natural substances. *Petroleum engineering* deals specifically with processes involving petroleum.

Electrical and Electronic Engineering: The branch of engineering that deals with the effects and processes resulting from the behavior of tiny particles of matter called electrons.

Aerospace Engineering: A branch of engineering that deals with flight in the earth's atmosphere or in space.

Nuclear Engineering: A modern branch of engineering that deals with the processes resulting from the break-up of some particles of matter.

Systems Engineer: An engineer who coordinates the work of other engineers from different disciplines who are involved in one project.

Profession: An occupation such as law, medicine or engineering which requires specialized education at the university level.

The Engineering Profession

Engineering is one of the oldest occupations in history. Without the skills included in the broad field of engineering, our present-day civilization never could have evolved. The first toolmakers who chipped arrows and spears from rock were the forerunners of modern mechanical engineers. The craftsmen who discovered metals in the earth and found ways to refine and use them were the ancestors of mining and metallurgical engineers. And the skilled technicians who devised irrigation systems and erected the marvelous buildings of the ancient world were the civil engineers of their time. One of the earliest great names in history is that of Imhotep, designer of the stepped pyramid at Saqqarah in Egypt built in the twenty-seventh century B.C.

Engineering is often defined as making practical application of theoretical sciences such as physics and

mathematics. Many of the early branches of engineering were based not on science but on *empirical information* that depended on observation and experience rather than on theoretical knowledge. Those who devised methods for splitting the massive blocks that were needed to build Stonehenge in England or the unique pyramids of Egypt discovered the principle of the *wedge by* trial and error rather than by mathematical calculations. The huge blocks of stone for the pyramids were probably raised into place by means of ramps of earth that surrounded the structures as they rose; it was a practical application of the *inclined plane,* even though the concept was not understood in terms that could be quantified or expressed mathematically.

Quantification has been one of the principal reasons for the explosion of scientific knowledge since the beginning of the modern age in the sixteenth and seventeenth centuries. Another important factor has been the development of the experimental method to verify theories. Quantification involves putting the data or pieces of information resulting from experimentation into exact mathematical terms. It cannot be stressed too strongly that mathematics is the language of modern engineering.

The great engineering works of ancient times were constructed and operated largely by means of slave labor. After the fall of the Roman Empire there were fewer slaves available in Europe. During the Middle Ages people began to seek devices and methods of work that were more efficient and humane. Wind, water, and animals were used to provide energy for some of these

new devices. This kind of experimentation eventually led to what is known as the Industrial Revolution which began in the eighteenth century. First steam engines and then other kinds of machines took over more and more of the work that had previously been done by human beings or by animals.

Since the nineteenth century both scientific research and practical application of its results have escalated. One result of the rapid expansion of scientific knowledge was an increase in the number of engineering specialties. By the end of the nineteenth century not only were *mechanical, civil,* and *mining and metallurgical engineering* established but the newer specialties of *chemical* and *electrical engineering* emerged. This growth in the number of specialties is continuing with the establishment of such disciplines as *aerospace, nuclear, petroleum,* and *electronic engineering*. Many of these are subdivisions of earlier specialties- for example, electronic from electrical engineering or petroleum from chemical. Within the field of mechanical engineering the major subdivision is *industrial engineering* which is concerned with complete mechanical systems for industry rather than individual machines.

Because of the large number of engineering fields today there are often many different kinds of engineers working on large projects such as the development of nuclear power or new aircraft. In the design of a new aircraft mechanical engineers work not only on the plane's engines but also on other mechanical aspects such as the braking system. When the aircraft goes into production mechanical and industrial engineers are

involved in designing the machines necessary to fabricate the different parts as well as the entire system for assembling them. In both phases of such a project mechanical engineers work with specialists in fields such as aerospace and electronic engineering. Each engineer is a member of a team often headed by a *systems engineer* able to combine the contributions made by all the different disciplines.

Another result of the increase of scientific knowledge is that engineering has become a *profession.* A profession is an occupation like law or medicine that requires specialized advanced education; such occupations are often called the "learned professions. "Until the nineteenth century engineers were for the most part craftsmen or project organizers who learned their skills through apprenticeship, on the job training, or simply by trial and error. Today it requires at least four or five years of university study leading to a Bachelor of Science degree. More and more often engineers, especially those engaged in research, get an advanced master's or doctor's degree. Even those engineers who do not study for advanced degrees must keep up with changes in their profession and those related to it. A mechanical engineer who does not know about new materials cannot successfully compete with one who does. All of this means that an engineer's education is never really finished so he or she must be willing to continue the learning process.

The word engineer is used in two senses in English. One, as just indicated, refers to the professional engineer who has a university degree and an education in

mathematics, science, and one of the engineering specialties. Engineer, however, is also used to describe a person who operates or maintains an engine or machine. An excellent example of this is the locomotive engineer who operates a train on a railroad. Engineers in this sense are essentially highly trained technicians rather than professional engineers as the term is used in this book.

The systems that engineers produce must be workable not only from a technical but also from an economic point of view. This means that engineers work with management and government officials who are cost-conscious so the engineer must accommodate his or her ideas to the financial realities of the particular project.

The public has become much more aware, especially in the last decade, of the social and environmental consequences of engineering projects. For much of the nineteenth and twentieth centuries, the public attitude could be summed up in the phrase "Science is good," and the part of science that was most visible was the engineering work that made scientific knowledge useful. Countless cars and other mechanical devices are part of our engineered environment.

Today, however, people are more conscious of the hidden or delayed hazards in products and processes. The automobile is a typical example. No one disputes its convenience but many are also aware of the air pollution it causes and the amount of energy it consumes. Engineers are working to solve these problems by designing devices that reduce pollution and improve fuel efficiency.

The engineer, then, does not work in a scientific vacuum but must take into account the social consequences of his or her work. Engineering is described as a profession that finds practical application of theoretical science. A successful engineer must enlarge the definition of *practical* to include the idea that the work is safe and desirable for society.

Discussion

1. Who were the forerunners of modern mechanical, mining and metallurgical, and civil engineers?
2. What is one of the earliest names we know in relation to building?
3. How is engineering often defined?
4. What kind of information were many of the early branches of engineering based on? Give some examples.
5. Name two important factors in the explosion of scientific knowledge in modern times.
6. What made people in the Middle Ages in Europe begin to experiment with new devices and methods of work?
7. What was the historical result of experimentation with different kinds of energy?
8. By the end of the nineteenth century, what engineering specialties were developed?
9. What are some other engineering specialties that have become established since then?
10. What is the major subdivision within the field of mechanical engineering?
11. Why do many different kinds of engineers often work on a single project? Give an example.
12. Who is often the head of a project where different kinds of engineers are working together?
13. What has made engineering one of the learned professions?
14. How has the education of an engineer changed since the nineteenth century?
15. Why does an engineer need constant new learning?

16. How do the two meanings of the word *engineer* differ from each other? How will the word *engineer* be used in this book?
17. Discuss two ways in which the systems that engineers produce must be workable.
18. How has the attitude of the general public recently changed toward engineering projects?
19. The automobile is a typical example of the public's divided attitude toward engineering projects. Discuss this.
20. What are engineers working on in connection with this problem?
21. What concept must an engineer include in his or her definition of *practical?*

Review

A. Complete the following sentences with the appropriate word or phrase.

1. ____________ can be defined as the practical application of the findings of theoretical science.
2. A locomotive engineer who operates a train on a railroad is a __________ rather than a member of a profession.
3. Law, medicine, and engineering are professions which require specialized education at the ___________ level.
4. ____________ engineering deals with sources of energy and the machines that make use of them.
5. __________ engineering is concerned with structures and systems that are intended to be stationary.
6. ____________ engineers work with reactions among the elements, the basic natural substances.
7. ____________ engineering is concerned with complete mechanical systems for manufacturing processes rather than individual machines.
8. __________ and __________ engineers work with the effects and processes involving tiny particles of matter called electrons.

9. __________ and __________ engineers deal with getting materials from the earth and refining them.
10. ____________ engineers deal with processes that result from the breakup of certain small particles of matter.
11. ____________ engineers are concerned with flight in the earth's atmosphere or beyond it.

12. A __________ engineer often coordinates the work of engineers from several different fields when they are involved in the same project.
13. __________ information is acquired by observation or experience rather than through calculation and experimentation.
14. _________ means stating data in terms of exact mathematical equivalents.
15. A __________ is one of the simple or basic machines; it is a triangle with a very sharp angle at one end.

16. Another simple or basic machine is the __________ which is a surface that is at an angle to the horizontal.

B. Here are some projects on which an engineer might work. Indicate which branch of engineering (mechanical, civil, chemical, etc.) would be involved. Some of the projects may involve more than one kind of engineering; if so, indicate all of those you think should be included.

1. A suspension bridge over a large body of water. ____________________
2. Finding a new alloy (mixture) of metals that will serve certain special purposes. ____________________
3. Designing a control system for the safe operation of a nuclear reactor in an electric power plant. ____________________
4. Designing the wings for a new type of airplane. ____________________
5. Designing an automatic switching ____________________

system for telephone direct dialing.

6. Installing an automated conveyer belt in an automobile assembly plant. ________________
7. Testing the strength of materials to be used in the construction of a sports stadium. ________________
8. Designing and building an experimental model of a mechanical system to generate electricity from the movement of the waves in the ocean. ________________
9. Designing a rocket for space exploration that will use nuclear-powered motors. ________________
10. Designing a process for making plastics from vegetable materials such as soybeans. ________________

UNIT TWO

Engineering Education

Special Terms

Statistics: A branch of mathematics that deals with gathering, classifying, and using numerical data (pieces of information).

Probability: A branch of statistics that deals with what may happen when different factors can change the results of a problem.

Mathematics is the discipline that deals with concepts such as quantity, structure, space and change. It evolved, through the use of abstraction and logical reasoning, from counting, calculation, measurement and the study of the shapes and motions of physical objects.

A variable is a symbol denoting a quantity or symbolic representation. In mathematics, a variable often represents an unknown quantity that has the potential to change; in computer science, it represents a place where a quantity can be stored. Variables are often contrasted with constants, which are known and unchanging.

An environment is a complex of surrounding circumstances, conditions, or influences in which a thing is situated or is developed, or in which a person or organism lives, modifying and determining its life or character.

To Design: To prepare or work out the plan for some kind of work; civil engineers work out the ***design*** for projected structures.

A calculation is a deliberate process for transforming one or more inputs into one or more results. The term is used in a variety of senses, from the very definite arithmetical calculation using an algorithm to the vague heuristics of calculating a strategy in a competition or calculating the chance of a successful relationship between two people.

Computer programming (often simply **programming** or **coding**) is the craft of writing a set of commands or instructions that

can later be compiled and/or interpreted and then inherently transformed to an executable that an electronic machine can execute or "run".

Geodesy also called **geodetics**, is the scientific discipline that deals with the measurement and representation of the earth, its gravitational field and geodynamic phenomena (polar motion, earth tides, and crustal motion) in three-dimensional, time-varying space.

Surveying is the technique and science of accurately determining the terrestrial or three-dimensional space position of points and the distances and angles between them.

Hydraulics is a science and engineering subject dealing with the mechanical properties of liquids. Hydraulics is part of the more general discipline of fluid power.

Engineering Education

As we noted in the first unit, engineering is a profession, which means that an engineer must have a specialized university education. Many government jurisdictions also have licensing procedures which require engineering graduates to pass an examination, similar to the bar examinations for a lawyer, before they can actively start on their careers.

In the university, mathematics, physics, and chemistry are heavily emphasized throughout the engineering curriculum, but particularly in the first two or three years. Mathematics is very important in all branches of engineering, so it is greatly stressed. Today, mathematics includes courses in *statistics*, which deals with gathering, classifying, and using numerical data, or pieces of information. An important aspect of statistical

mathematics is *probability,* which deals with what may happen when there are different factors, or variables, that can change the results of a problem. Before the construction of a bridge is undertaken, for example, a statistical study is made of the amount of traffic the bridge will be expected to handle. In the design of the bridge, variables such as water pressure on the foundations, impact, the effects of different wind forces, and many other factors must be considered.

Because a great deal of calculation is involved in solving these problems, computer programming is now included in almost all engineering curricula. Computers, of course, can solve many problems involving calculations with greater speed and accuracy than a human being can. But computers are useless unless they are given clear and accurate instructions and information-in other words, a good program.

In spite of the heavy emphasis on technical subjects in the engineering curriculum, a current trend is to require students to take courses in the social sciences and the language arts. We have already discussed the relationship between engineering and society; it is sufficient, therefore, to say again that the work performed by an engineer affects society in many different and important ways that he or she should be aware of. An engineer also needs a sufficient command of language to be able to prepare reports that are clear and, in many cases, persuasive. An engineer engaged in research will need to be able to write up his or her findings for scientific publications. The last two years of an engineering program include subjects within the student's field of

specialization. For the student who is preparing to become a civil engineer, these specialized courses may deal with such subjects as geodetic surveying, soil mechanics, or hydraulics.

Active recruiting for engineers often begins before the student's last year in the university. Many different corporations and government agencies have competed for the services of engineers in recent years. In the science-oriented society of today, people who have technical training are, of course, in demand. Young engineers may choose to go into environmental or sanitary engineering, for example, where environmental concerns have created many openings; or they may choose construction firms that specialize in highway work or they may prefer to work with one of the government agencies that deals with water resources. Indeed, the choice is large and varied.

When the young engineer has finally started actual practice, the theoretical knowledge acquired in the university must be applied. He or she will probably be assigned at the beginning to work with a team of engineers. Thus, on-the-job training can be acquired that will demonstrate his or her ability to translate theory into practice to the supervisors.

Discussion

1. What does the fact that engineering is a. profession mean to someone who is interested in becoming an engineer?
2. What do many licensing procedures require?
3. What kinds of courses are stressed in the first two or three years of an engineering curriculum in a university?

4. What mathematics subject is included in the course? What is an important aspect of this subject? Why is this important?
5. Why is computer programming included in engineering courses? Only in what circumstances can a computer do an accurate job?
6. What courses besides technical ones are included in the engineering curriculum?
7. Why does an engineer need to take courses in social sciences and language arts?
8. When will an engineering student probably begin to take courses in his or her own field of specialization? What might some of these courses be for a student of civil engineering?
9. What are some of the fields of civil engineering in which a graduate engineer might specialize?

Review

A. Fill in each of the blanks in the following sentences with the appropriate word or expression.

1. __________ engineering systems provide clean water supply, drainage, and waste disposal services.
2. Some __________ are used only for excess water runoff, but others also carry domestic wastes.
3. Harmful substances can be removed from waste materials in a _______________, __________ plant.
4. Water can be stored in a __________, which is an artificial lake or body of water.
5. The process of passing water through sand or gravel to remove solids is known as __________
6. In aeration, sprays of water are shot into the air where __________ kills many of the bacteria.
7. __________ is a chemical that kills bacteria and is often used therefore in water purification systems.
8. In __________, wastes are allowed to settle until they become solid or semisolid and can be removed.

9. The __________ process involves the use of compressed air to increase and control the rate of biological reactions that purify wastes.
10. Many kinds of __________ such as newspapers, glass, and aluminum can be reclaimed in a process known as
11. A great deal of trash is completely burned up in __________

Linguistic Drills

Man in Society

Men usually want to have their own way. They want to think and act as they like. No one, however, can have his own way all the time. A man cannot live in society without considering the interests of others as well as his own interests. 'Society' means, a group of people with the same laws and the same way of life. People in society may make their own decisions, but these decisions ought not to be *unjust* or *harmful* to others. One man's decisions may so easily *harm* another person. For example, a *motorist* may be in a hurry to get to a friend's house. He sets out, driving *at full speed* like a *competitor* in a motor race. There are other *vehicles* and also *pedestrians* on the road. Suddenly there is a *crash.* There are *screams* and *confusion.* One careless motorist has struck another car. The *collision* has injured two of the passengers and killed the third. Too many road accidents happen through the *thoughtlessness* of *selfish* drivers. We have governments, the police and the law courts to *prevent* or to *punish* such *criminal* acts. But in addition, all men ought to observe certain rules of *conduct.* Every man ought to *behave* with *consideration* for other men. He ought not to steal, *cheat,* or destroy the property of others. There is no place for this sort of *behaviour* in a *civilised* society.

Men in a free society have certain *privileges.* The government and the police do not watch all their movements. *Officials* do not *dictate* to them everything they may or may not do. Men in a free

society may think as they please. They may even choose their own government. In return for these privileges they ought not to act selfishly. They ought always to respect the rights of others. It is very important for men to remember this. *Wherever* they may live, *whether* in a town or in a village, in a large or a small *community,* they ought not to behave thoughtlessly. The happiness of a community depends on the behaviour of its *individual* members. It is every good *citizen's* responsibility to give as well as to receive.

1. Find words in the passage to complete these sentences:

a) There was a terrible ___ as the two cars ran into each other.
b) As a result of the ___ between the two cars, two people were injured and one was killed.
c) Road accidents are caused by the ___ of selfish drivers.
d) We should obey the rules of ___ laid down by society.
e) In a free society we are not told what to think by government ___.
f) It is a great ___ to be allowed to borrow books from a library, so borrowers should treat the books carefully.
g) Man in society has ___as well as rights,
h) A good ___ respects the rights of others.
i) A town is a large ___ and a village is a small ___.
j) In a motor race the ___ drive at full speed.

2. Complete each sentence by selecting the correct phrase from those in brackets:

a) One man's decisions and acts may (sometimes harm another, never harm another, always harm another).
b) Motorists (ought to drive carefully, ought to drive selfishly, are responsible for all road accidents).
c) There are (too many road accidents, not enough road accidents, a satisfactory number of road accidents).
d) It is (right and thoughtful, not really necessary, very selfish) to respect the rights of others.
e) Members of a civilised society usually (steal and cheat, harm the interests of others, behave in a responsible way).

3. Fill the blanks with "ought to" or" ought not to":

a) Students who want to do well___ work hard.
b) You ___ keep drinking water covered.
c) Borrowers ___ keep books out for longer than the library rules allow.
d) Motorists ___drive carefully and with consideration.
e) Men ___ steal or cheat.

4. Rearrange Column B so that each word or phrase is opposite the one in Column A which it explains:

A	B
to endanger	a person who drives a car
decision	not fair
unjust	a collision
a privilege	a single person
a competitor	ruling
an individual	not caring for others
a crash	the act of deciding
a motorist	a special favour or right
governing	someone taking part in a race
selfish	to expose to harm

5. Give the opposite of each of the following adjectives by putting the prefix im- or un- before it or by using the suffix -less after it, whichever is required:

careful, just, interesting, likely, patient, possible, selfish, thoughtful, truthful

6. Fill the blanks with for or to:

a) People too often want __ have their own way.
b) The driver was in a hurry ___ get to his friend's house.
c) Some people are too selfish ___ consider the needs of others.
d) It is important ___ men ___ respect the rights of others.
e) The motorist was punished by the court ___ driving too fast.

7. Fill the blanks with a, an or the where necessary:

a) He was in ___ great hurry to get to his friend's house.
b) Accidents happen through ___ carelessness of motorists.
c) All good citizens ought to help ___ prevent crimes.
d) Men in a free society have both ___ privileges and ___ responsibilities.
e) Whether we live in ___ large or in ___ small community we ought not to act without ___ respect for others.

UNIT THREE

CIVIL ENGINEERING (1)

Special Terms

beam: as used here, the horizontal support of a structure
The structural engineer will have to figure the size of beams. The load on a beam determines its size and shape.
The stress on a beam is an important structural problem.

civil engineer: an engineer whose specialty is the design and construction of buildings, roads, harbors, irrigation systems, and works of a similar nature. I want to talk with you about the work of a civil engineer. The term "civil engineer" was set up as a distinction from the military engineer. The civil engineer has often done work of a pioneering nature.

consultant engineer: an expert in a specific field of engineering whose function is to provide professional advice and services. A small percentage of civil engineers become consultant engineers. It is important that a consultant engineer be familiar with modern developments.
It is often necessary for a firm to hire a consultant engineer.

dam: a barrier across water controlling its flow
What about dams?
The strength of a dam is an important design consideration.
Dams can greatly affect wide geographical areas.

industrial waste: material left over from industrial production
Sanitary engineering deals with industrial wastes.
Strict laws govern the handling of industrial wastes.
Industrial wastes often make our rivers impure.

irrigation: the artificial watering of land
It includes problems in irrigation.
Irrigation plays an important role in agriculture.
Floods can sometimes be helpful to irrigation.

sanitary engineering: a branch of civil engineering dealing with sewage and waste problems Another area, not so well known, is sanitary engineering.
The need to control disease was one of the reasons for the development of sanitary engineering. Sanitary engineering grew out of a combination of physical and biological sciences.

sewage: waste matter usually disposed of by drains Sanitary engineering deals with sewage. The handling of sewage is important in civic planning. Sanitary and storm sewage sometimes form two separate systems.

strain: the change of shape or size of a body through the action of a force. He will have to figure strains.
The strain of a body is sometimes also called the deformation.*
How much strain will occur in this case?

stress: force between touching surfaces of bodies, due to external forces. He will have to figure stresses.
The stress developed per unit of area is called unit stress.
The study of stresses is essential to an engineer.

structure: something constructed, usually of large size; the manner of construction; the part of a construction responsible for its strength
His job is to make sure that the structures are sound.
That bridge has an impressive and beautiful structure.
The roof structure of this building is too weak.

transportation engineering: the branch of civil engineering dealing with the design and construction of high ways, railroads, airports, etc. One of the better known areas transportation engineering. The design of roads is an important field of transportation engineering. Economic and human problems are often involved in transportation engineering.

Dialogue:

Professor:	Have a seat What can I do for you?
Student:	I'm going to be an engineer, but I'm having a little trouble deciding which field to go into. The Dean suggested that I have a talk with you about the work of a civil engineer.
Professor:	Well, I don't know how helpful I can be, but I'll be glad to give you some general idea of the field.
Student:	Good. That's just what I want.
Professor:	One of the better known areas is construction engineering. It deals with the construction of all kinds of structures, like bridges, factories, dams, and so on.
Student:	Does it include the design?
Professor:	Not necessarily. The structural engineer will usually do this. His job, of course, is to follow the general design and make sure that the structures are sound. He will have to figure stresses and strains, size of beams, etc. It's a very demanding field, because it usually involves a great deal of mathematics.
Student	I see. What about water control, in general?
Professor:	Oh, yes. This is an important field. It includes problems in irrigation, flood control, and water supply. Another

	area, not so well known, is sanitary engineering, which deals with sewage and industrial waste.
Student	Road building must also be an important field.
Professor:	And a very complex one. Transportation engineering doesn't involve only roads, by the way. For instance, airport design and construction is a major concern.
Student	Do civil engineers usually work with a company?
Professor:	Usually, yes. There are large as well as small civil engineering firms. Their size depends on the scale of the projects they undertake. A smaller number of civil engineers become what are known as consultant engineers. They are experts in particular fields, and they are consulted by larger firms on specific projects.
Student	Well, thank you very much.
Professor:	O K. Lots of luck in your career.

Check-Up

Insert the proper terms in the blanks.

irrigation
sanitary engineering
consultant engineer
dam

transportation engineer
strain
industrial wastes
beams

1. This firm needs advice on a new project. They're hiring a ___.
2. This field deals with the disposal of wastes. It's called ___.
3. The building didn't have enough horizontal support. The ____ were not strong enough.
4. That part of the country is quite dry. ____ would make much of it usable for agriculture.
5. They want to control the flow of water in that river. They're going to build a ____.
6. The weight has changed the shape of this iron bar. It has undergone a lot of ___.
7. They're hiring a man to design an airport. He's a ___.
8. The factories have made the river impure. It's full of ___.

Linguistic Drills

The Sinking of the Titanic

In 1912 an American *shipping* company *launched* a new ship called the 'Titanic'. It was the largest and most *luxurious* ocean *liner* of that time. It weighed 46,000 tons and could carry about 2,200 passengers. *Experts* said that nothing could sink it. It was definitely *unsinkable*. On April 14 1912, the ship sailed on its first voyage across the Atlantic from Southampton in England to New York in the United States, with 2,224 passengers, men, women and children. On April 15, just before midnight, the ship struck an *iceberg*. The iceberg tore a great hole in the ship's side, and the unsinkable 'Titanic' began to sink.

There was great *alarm on board*. *Warning* bells rang out. Everyone rushed to the *lifeboats*, but there was not enough room for them all. There was room for only 1,178 passengers. The lifeboats took *mostly* the women and children. It was a terrible scene. Wives were *weeping* because they had to leave their husbands to *drown*. Children were crying because they had to say goodbye to their fathers. The men had to remain on the ship. The 'Titanic' sent out signals for help, but no help came. Another ship,

the 'Californian', was only twenty miles away, but her radio *operator* was asleep and did not hear the *distress* signals.

In the early hours of the morning the 'Titanic' sank, while her band was playing bravely *on deck*. Twenty minutes later another liner, the 'Carpathia', arrived on the scene and helped to rescue *survivors* from the icy water. But of the 2,224 passengers, only about 700 *survived*.

It was a terrible *disaster*. But something good came out of the sinking of the 'Titanic'. In 1913 there was a committee of inquiry into the disaster. This committee drew up many new rules for shipping companies. Since then, every ship has had to provide lifeboat places for each passenger and has had to organize lifeboat *drill* during each voyage. Every ship has had to carry enough radio operators so that there is always one of them on duty. Another important result of the sinking of the 'Titanic' was the *formation* of an international ice *patrol*. This patrol warns ships about ice and icebergs in the North Atlantic.

1. Are these statements true or untrue?

a) The 'Titanic' was unsinkable.
b) The 'Titanic' was sailing from east to west.
c) The 'Californian' rescued survivors from the 'Titanic'.
d) Many passengers were lost because some of the lifeboats struck an iceberg.
e) There were not enough places in the lifeboats for all the passengers.
f) The 'Californian' had a radio operator on duty all the time.
g) About 1,500 of the passengers on the 'Titanic' lost their lives,
h) The international ice patrol warns ships about icebergs in the North Pacific.

2. Column B contains explanations of the words in Column A, but not in their correct order. Rearrange Column B so that each explanation is opposite the appropriate word in Column A:

A	B
to warn	to put (a new ship) into the water

a lifeboat	very costly and comfortable
luxurious	a group of musicians playing together
a disaster	to tell about possible danger
a voyage	a large passenger ship
to launch	a terrible accident
a liner	a man who sends and receives wireless messages
a radio operator	a journey by sea
a band	part of a ship that people walk on
a deck	a boat for rescuing people from the sea

3. Find suitable words in the passage to complete these sentences:

a) Radio operators must not sleep when they are on ___.
b) Bells rang out to give ___ of the disaster.
c) The passengers were standing on the ___, waiting to get into the lifeboats.
d) The shipbuilders thought the 'Titanic' was ___ even in a collision.
e) An ___is a person with special knowledge of a subject.
f) When the ship struck the iceberg the radio operator sent out___ signals.
g) The 'Titanic' sailed with more than 2,000 passengers on ___.
h) Soldiers spend a lot of time doing ___, to learn to obey orders and move together.

4. Put the verbs in brackets into their correct form:

a) Many passengers (sleep) when the alarm bells (ring) out.
b) The band (play) bravely on deck while the ship (sink).
c) When the 'Carpathia' (come) on the scene hundreds of passengers (struggle) in the icy water.
d) When the lights (go) out we (sit) in the kitchen.
e) While some passengers were (get) into the lifeboats, others (jump) into the water.
f) When the patrol (see) the iceberg, all ships in the area (keep) a careful watch and their radio operators (listen) for warnings.

5. Fill the blanks with in or on:

a) The 'Titanic' was _ her first voyage.
b) Every ship must have a radio operator ___ duty all the time, ___case other ships need help.
c) Another ship came ___ the scene and picked up survivors.
d) Some passengers were ___ deck and others were ___ their cabins.
e) The disaster happened ___ April 15 1912.

6. Fill the blanks with can, cannot, may or may not, whichever is needed:

a) 'This ship ___ sink,' said the experts who built the 'Titanic'.
b) Liners ___ sail without enough lifeboats for all their passengers.
c) A radio operator ___ do his duty if he is asleep.
d) Lifeboats ___ be needed quickly if there is a collision.
e) You ___ not understand why it sank so quickly, perhaps, but you ___be quite sure that it did.

7. Rewrite these sentences, giving the past participles of the verbs in brackets:

a) The 'Titanic' was (strike) by an iceberg.
b) A great hole was (tear) in the ship's side.
c) Distress signals were (send) out by the radio operator.
d) The distress signals were not (hear) by the radio operator of the 'Californian'.
e) Some of the passengers were (take) off in lifeboats.
f) Many people were (see) struggling in the water by the crew of the 'Carpathia'.
g) A committee of inquiry was (hold) after the disaster.
h) New rules for shipping were (draw) up by the committee.
i) International patrols are now (send) out regularly to look for ice.
j) Ships are (warn) by the patrol about icebergs in the North Atlantic.

UNIT FOUR
CIVIL ENGINEERING (2)

Special Terms

Engineering: the practical application of the findings of theoretical science so that they can be put to work for the benefit of mankind. *An engineer* is a member of the engineering profession, although this term is also used to refer to someone who operates or maintains certain kinds of equipment -a *railroad locomotive engineer,* for example. In the latter context, the person referred to is a technician rather than a professional engineer.

Civil Engineering: The branch of engineering that deals with the design and construction of structures that are intended to be stationary, such as buildings, dams, and bridges. Among its subdivision are *structural engineering,* dealing with permanent structures; *hydraulic engineering,* dealing with the flow of water and other fluids; and *environmental/sanitary engineering,* dealing with water supply, water purification, and sewer systems, as well as urban planning and design.

Research: Looking for basic facts or principles *(basic research)* or for ways to apply such knowledge *(applied research).*

To Design: To prepare or work out the plan for some kind of work; civil engineers work out the *design* for projected structures.

Feasibility Study: A study to determine whether a project is practicable or not. The study must consider not only structural features, but also economic factors and possible alternatives, or other choices.

Consulting Engineers; Consultants: Engineers or other specialists who offer their services to a number of different customers on a job-by-job basis. They usually work for relatively short periods of time to solve specific problems for their customers.

Stress: physical pressure or other forces exerted on an object. The force of gravity, the natural pull of the earth, for example, is one of the stresses that acts on an object.

Systems Engineers: Engineers who understand and have experience in several different fields of engineering so that they can coordinate work on systems or projects that involve two or more engineering specialties.

Construction: The actual work of building a project. From an engineering viewpoint it includes such activities as scheduling and supervising the work.

Maintenance: Keeping existing systems, structures, or equipment in working order.

Sales: The selling of construction equipment, an area in which some civil engineers specialize.

Management: The establishment and carrying out of policies for an organization. Some civil engineers work in management of corporations; others form companies of their own. Knowledge of administration and finance is essential.

CIVIL ENGINEERING

The term civil engineering originally came into use to distinguish it from military engineering. Civil engineering dealt with permanent structures for civilian use, whereas military engineering dealt with temporary structures for military use. An example of the latter is the bridge built across the Rhine in 55 B.C. that is described in Julius Caesar's *Commentaries on the Gallic war.* A more appropriate definition of civil engineering is that it deals with the design and construction of objects that are intended to be stationary. In practice, this definition includes buildings and houses, dams, tunnels, bridges, canals, sanitation systems, and the stationary parts of

transportation systems-highways, airports, port facilities, and roadbeds for railroads.

Civil engineering offers a particular challenge because almost every structure or system that is designed and built by civil engineers in unique. One structure rarely duplicates another exactly. Even when structures seem to be identical, site requirements or other factors generally result in modifications. Large structures like dams, bridges, or tunnels may differ substantially from previous structures. The civil engineer must therefore always be ready and willing to meet new challenges.

As scientific knowledge increased, so did the practical applications. The eighteenth century witnessed the beginning of what is usually called the Industrial Revolution, in which machines began to do more and more of the work that previously had been done by human beings or animals. In the nineteenth century and in our own day, both scientific research and the practical applications of its results have progressed rapidly. They have given the civil engineer new and stronger materials; the mathematical formulas which he can use to calculate the *stresses* that will be encountered in a structure; and machines that make possible the construction of skyscrapers, dams, tunnels, and bridges that could never have been built before.

Another result of the explosion of knowledge was an increase in the number of scientific and engineering specialties. Within the field of civil engineering itself, there are subdivisions: structural engineering, which deals with permanent structures; hydraulic engineering, which

is concerned with systems involving the flow and control of water or other fluids; and sanitary or environmental engineering, which involves the study of water supply, purification, and sewer systems. Obviously, many of these specialties overlap. A water supply system, for example, may involve dams and other structures as well as the flow and storage of water.

The civil engineer may work in research, design, construction supervision, maintenance, or even in sales or management. Each of these areas involves different duties, different emphases, and different uses of the engineer's knowledge and experience.

Research is one of the most important aspects of scientific and engineering practice. A researcher usually works as a member of a team with other scientists and engineers. He or she is often employed in a laboratory that is financed by government or industry. Areas of research connected with civil engineering include soil mechanics and soil stabilization techniques, and also the development and testing of new structural materials.

We noted that civil engineering projects are almost always unique; that is, each has its own problems and design features. Therefore, careful study is given to each project even before design work begins. The study includes a survey both of topographical and subsoil features of the proposed site. It also includes a consideration of possible alternatives, such as a concrete gravity dam or an earth-fill embankment dam. The economic factors involved in each of the possible

alternatives must also be weighed. Today, a study usually includes a consideration of the environmental impact of the project. Many engineers, usually working as a team that includes surveyors, specialists in soil mechanics, and experts in design and construction, are involved in making these *feasibility studies.*

Many civil engineers, among them the top people in the field, work in design. As we have seen, civil engineers work on many different kinds of structures, so it is normal practice for an engineer to specialize in just one kind. In designing buildings, engineers often work as *consultants* to architectural or construction firms. Dams, bridges, water supply systems, and other large projects ordinarily employ several engineers whose work is coordinated by a *systems engineer* who is in charge of the entire project. In many cases, engineers from other disciplines are involved. In a dam project, for example, electrical and mechanical engineers work on the design of the powerhouse and its equipment. In other cases, civil engineers are assigned to work on a project in another field; in the space program, for instance, civil engineers were necessary in the design and construction of such structures as launching pads and rocket storage facilities.

Construction is a complicated process on almost all engineering projects. It involves scheduling the work and utilizing the equipment and the materials so that costs are kept as low as possible. Safety factors must also be taken into account, since construction can be very dangerous. Many civil engineers therefore specialize in the construction phase.

After the structure has been completed, it must be kept from falling into disrepair; therefore many engineers specialize in *maintenance*. This is often a function of the privately owned utility or governmental agency that will ultimately be responsible for the completed structure. A large system like the California State Water Project obviously requires a large maintenance staff under the supervision of qualified engineers.

Some engineers also work in *sales*. Companies that supply products or equipment for construction often employ civil engineers as part of their sales staffs. The customers are engineers themselves, and so they must be given the opportunity to communicate with salespeople who can understand the same technical specifications. A few engineers may also go into *management-the* establishment or carrying out of the policies of the companies that employ them. Construction companies are often headed by civil engineers; indeed, some of these companies were founded by engineers. No matter what the path into management may be, these engineers must have administrative as well as technical skills.

Many civil engineers work for government agencies; many others work as consultants, providing their knowledge and experience to solve problems in their field on a job-to-job basis. Since the building of a structure is ordinarily a unique endeavor, consulting is a particularly common practice among civil engineers. A successful consulting engineer must have a wide range of experience and knowledge, as well as the ability to work easily with other people, such as real estate developers,

government officials, or ordinary citizens whose lives will be affected by a project.

Much of the work of civil engineers is carried on outdoors, often in rugged and difficult terrain or under dangerous conditions. Surveying is an outdoor occupation, for example, and dams are often built in wild river valleys or gorges. Bridges, tunnels, and skyscrapers under construction can also be dangerous places to work. In addition, the work must also progress under all kinds of weather conditions. The prospective civil engineer should be aware of the physical demands that will be made on him or her.

Discussion

1. How does civil engineering differ from military engineering? What is a classical example of a structure built for military purposes? Can you think of any modern examples?
2. What is a more appropriate definition of civil engineering? What does this definition include?
3. Why does civil engineering offer a particular challenge? What consequence does this have for civil engineering?
4. What began in the eighteenth century? Has this movement continued up to the present?
5. What have scientific research and the practical applications of its results given the civil engineer?
6. What are some of the subdivisions within the field of civil engineering?
7. What are some of the lands of work in which a civil engineer may specialize? What does each of these involve?
8. Where is a researcher often employed?

9. What are some of the areas of research connected with civil engineering? What are some others that are not mentioned in the reading?
10. Why is careful study given to each civil engineering project before design work begins?
11. What are some of the things that are included in such a study?
12. Who is involved in making such studies? What are they called?
13. Why don't all civil engineers specialize in the design of all lands of different structures?
14. What kind of engineer would be in charge of a large project involving several different engineering fields? What engineers besides civil engineers would be employed on a dam project? In what kind of project would civil engineers be brought in as consultants?
15. Why is construction a complicated process?
16. Why must safety factors be taken into consideration in construction?
17. Who may employ engineers who specialize in maintenance?
18. What kind of companies often employ civil engineers on their sales staff? Why?
19. How do some engineers get into management? What kinds of skills must these engineers have?
20. Why is consulting a particularly common practice among civil engineers?
21. What special ability must a consulting engineer have?
22. What lands of physical demands may be made on a civil engineer?

Review

1. -------------- engineering is concerned with structures and systems that are intended to be stationary.
2. -------------- engineering ordinarily deals with temporary structures that are used in warfare.

3. ------------- engineering deals with the flow and control of liquids, especially water.
4. -------------- engineers help to provide cities and towns with clean and adequate supplies of water.
5. A ----------- engineer might work on a dam, a bridge, or a skyscraper.
6. ------------- engineering deals with sources of power and the machines that make use of them.

B. Describe the water supply, drainage, and sewage disposal system of your community. You should indicate the source of the water, the way it is transported to the community, and the steps taken to keep it pure. You should also indicate whether there is a combined or separate sewer system for runoff water and domestic wastes, where the wastes are released, whether there are sewage treatment plants, and if so what processes are used in them.

UNIT FIVE
ARCHITECTURAL ENGINEERIN

Special Terms

Design: usually considered in the context of the applied arts, engineering, architecture, and other such creative endeavours, is used as both a noun and a verb.

Urban, city, or town planning: is the discipline of land use planning which deals with the physical, social, and economic development of metropolitan regions, municipalities and neighbourhoods.

Landscape architecture: is the art, planning, design, management, preservation and rehabilitation of the land and the design of man-made constructs. The scope of the profession includes architectural design, site planning, estate development, environmental restoration, town or urban planning, urban design, parks and recreation planning, regional planning, and historic preservation.

Construction: is the building or assembly of any infrastructure. Although this may be thought of as a single activity, in fact construction is a feat of multitasking. Normally the job is managed by the construction manager, supervised by the project manager, design engineer or project architect.

Aesthetics: is a branch of value theory which studies sensory or sensori-emotional values, sometimes called judgments of sentiment or taste. What makes something beautiful? Or sublime? Or disgusting, fun, cute, silly, entertaining, pretentious, discordant, harmonious, boring, humorous, tragic etc.?

Structural biology: is a branch of molecular biology concerned with the study of the architecture and shape of biological macromolecules--proteins and nucleic acids in particular—and what causes them to have the structures they have.

Computer software: (or simply **software**) is the programs that enable a computer to perform a specific task, as opposed to the physical components of the system (hardware).

Map or **mapping** is often a synonym for function in mathematics and related technical fields. Thus, for example, a partial map is a partial function, and a total map is a total function.

Applied science: is the exact science of applying knowledge from one or more natural scientific fields to practical problems. Many applied sciences can be considered forms of engineering. Applied science is important for technology development.

A residential area: is a type of land use where the predominant use is housing. In areas that are zoned residential, buildings may include single family housing, multiple family housing such as (apartments, duplexes, town homes (or similar configurations), condominiums) or mobile homes.

Marcus Vitruvius Pollio: (born ca 80/70 BC?; died ca. 25 BC) was a Roman writer, architect and engineer, active in the 1st century BC.

De architectura: (Latin: "On architecture") was a treatise on architecture written by the Roman architect Vitruvius and dedicated to his patron, the emperor Caesar Augustus.

Interdisciplinarity: is a type of academic collaboration in which specialists drawn from two or more academic disciplines work together in pursuit of common goals.

The social sciences: are groups of academic disciplines that study the human aspects of the world. They diverge from the arts and humanities in that the social sciences emphasize the use of the scientific method and rigorous standards of evidence in the study of humanity.

Astronomy: It is concerned with the evolution, physics, chemistry, and motion of celestial (e.g., stars, planets, comets, and galaxies) objects, as well as the formation and development of the universe.

An architect: is a person involved in the planning, designing and oversight of a building's construction. In the broadest sense, an architect is a person who translates the user's needs into the builder's requirements.

Building material: is any material which is used for a construction purpose. Just about every type of available material has been used at one time or another for creating various human and animal homes, structures, and technologies. This

reference deals with habitats and structures including homes.

Vernacular architecture: is a term used to categorize a method of construction which uses immediately available resources to address immediate needs, as such it is often dismissively associated with crude and unrefined solutions.

Rural: areas ("the country", **countryside**) are sparsely settled places away from the influence of large cities and towns. People in rural areas live in villages, on farms and in other isolated houses, as in pre-industrial societies.

Islamic architecture: a part of the Islamic studies, is the entire range of architecture that has evolved within Muslim culture in the course of the history of Islam. Hence the term encompasses religious buildings as well as secular ones, historic as well as modern expressions and the production of all places that have come under the varying levels of Islamic influence.

École des Beaux-Arts: ("School of Fine Arts") refers to a number of influential Art schools in France. The most famous is now located on the left bank in Paris, across the Seine from the Louvre, in the 6th arrondissement.

Avant-garde: in French means front guard, advance guard, or vanguard. People often use the term in French and English to refer to people or works that are experimental or novel, particularly with respect to art, culture, and politics.

Ludwig Mies van der Rohe: is considered one of the masters of modern architecture. His methods and language may have been representative of architectures inspired by industry.

The International style: was a major architectural trend of the 1920s and 1930s.The term usually refers to the buildings and architects of the formative decades of modernism, before World War II.

Postmodernism: is a term usually used to describe a type of intellectual thought that is often considered a critique of (or reaction to) modernism.

Robert Charles Venturi: (June 25, 1925 -) is a Philadelphia-based architect who worked under Eero Saarinen and Louis Kahn before forming his own firm with John Rauch. As a faculty member at the University of Pennsylvania.

A building code: is a set of rules that specify the minimum acceptable level of safety for constructed objects. The main purpose of the building codes is to protect public health, safety and general welfare as they relate to the construction and occupancy of buildings and structures.

A landscape architect: is a person, generally speaking, with an education, whether academic or practical, in landscape architecture and whose professional work conforms to the practice of the same name. Architecture is the art and science of designing buildings and structures.

ARCHITECTURAL ENGINEERING

In modern usage, architecture is the art and discipline of creating an actual, or inferring an implied or apparent plan of any complex object or system. In everyday usage, an architecture may be seen as a subjective mapping from a human perspective (that of the user in the case of abstract or physical artifacts) to the elements or components of some kind of structure or system, which preserves the relationships among the elements or components.

Planned architecture often manipulates space, volume, texture, light, shadow, or abstract elements in order to achieve pleasing aesthetics. This distinguishes it from applied science or engineering, which usually concentrate more on the functional and feasibility aspects of the design of constructions or structures. In the field of building architecture, the skills demanded of an architect range from the more complex, such as for a hospital or a stadium, to the apparently simpler, such as planning residential houses. Many architectural works may be seen also as cultural and political symbols, and/or works of art.

The role of the architect, though changing, has been central to the successful design and implementation of pleasingly built environments in which people live.

According to the very earliest surviving work on the subject, **Vitruvius' De architectura**, good buildings satisfy three core principles: Firmness, Commodity, and Delight; architecture can be said to be a balance and coordination among these three elements, with none overpowering the others. A modern-day definition sees architecture as addressing aesthetic, structural, and functional considerations. However, looked at another way, function itself is seen as encompassing all criteria, including aesthetic, psychological, and cultural ones.

Architecture is an interdisciplinary field, drawing upon mathematics, science, art, technology, social sciences, politics, history, and philosophy. Vitruvius states: "Architecture is a science, arising out of many other sciences, and adorned with much and varied learning: by the help of which a judgement is formed of those works which are the result of other arts." He adds that an architect should be well versed in fields such as music and astronomy. Philosophy is a particular favourite; in fact the approach of an architect to their subject is often called their philosophy.

Architectural history

Architecture first evolved out of the dynamics between needs (shelter, security, worship, etc.) and means (available building materials and attendant skills). Prehistoric and primitive architecture constitute this early

stage. As humans progressed and knowledge began to be formalized through oral traditions and practices, architecture evolved into a craft. There is first a process of trial and error, and later improvisation or replication of a successful trial. What is termed Vernacular architecture continues to be produced in many parts of the world. Indeed, vernacular buildings make up most of the built world that people experience everyday.

Early human settlements were essentially rural. As surplus of production began to occur, rural societies transformed into urban ones and cities began to evolve. In many ancient civilizations such as the Egyptians', architecture and urbanism reflected the constant engagement with the divine and the supernatural, while in other ancient cultures such as Iran architecture and urban planning was used to exemplify the power of the state.

Islamic architecture has a long and complex history beginning in the seventh century. Examples can be found throughout the countries that are, or were, Islamic - from Morocco and Spain to Turkey, Iran and Pakistan. Other examples can be found in areas where Muslims are a minority. Islamic architecture includes mosques, madrasas, caravansarais, palaces, and mausolea of this large region.

With the Renaissance and its emphasis on the individual and humanity rather than religion, and with all its attendant progress and achievements, a new chapter began. Buildings were ascribed to specific architects - Michaelangelo, Brunelleschi, Leonardo da Vinci - and the cult of the individual had begun. But there was no

dividing line between artist, architect and engineer, or any of the related vocations. At this stage, it was still possible for an artist to design a bridge as the level of structural calculations involved was within the scope of the generalist.

With the consolidation of knowledge in scientific fields such as engineering and the rise of new materials and technology, the architect began to lose ground on the technical aspects of building. He therefore cornered for himself another playing field - that of aesthetics. There was the rise of the "gentleman architect" who usually dealt with wealthy clients and concentrated predominantly on visual qualities derived usually from historical prototypes. In the 19th century Ecole des Beaux Arts in France, the training was toward producing quick sketch schemes involving beautiful drawings without much emphasis on context.

Meanwhile, the Industrial Revolution laid open the door for mass consumption and aesthetics started becoming a criterion even for the middle class as ornamented products, once within the province of expensive craftsmanship, became cheaper under machine production. When Modern architecture was first practiced, it was an avant-garde movement with moral, philosophical, and aesthetic underpinnings. Modernist architects sought to reduce buildings to a pure form, removing historical references in favor of purely functional structures. The columns, arches, and gargoyles of Classical architecture were dubbed unnecessary. Buildings that flaunted their construction, exposing steel beams and concrete surfaces instead of hiding them

behind traditional forms, were seen as beautiful in their own right. Architects such as Mies van der Rohe worked to reject virtually all that had come before, trading handcrafted details and sentimental historic forms for a machine-driven architectural geometry made possible by the Industrial Revolution.

Many people saw Modernism as dull or even ugly. As the founders of the International Style lost influence, Postmodernism developed as a reaction against the purity of Modernism. Robert Venturi's contention that a "decorated shed" (an ordinary building which is functionally designed inside and embellished on the outside) was better than a "duck" (a building in which the whole form and its function are tied together) gives an idea of this approach.

As many other concerns began to be recognised and complexity of buildings began to increase in terms of aspects such as services, architecture started becoming more multi-disciplinary than ever. Architecture now required a team of professionals in its making, an architect being one among the many, sometimes the leader, sometimes not. This is the state of the profession today. However, individuality is still cherished and sought for in the design of buildings seen as cultural symbols - the museum or fine arts centre has become a showcase for new experiments in style: today one style, tomorrow maybe something else.

An architect is a person involved in the planning, designing and oversight of a building's construction. The word "architect" is derived from the Latin architectus or

from the Greek arkhitekton. In the broadest sense, an architect is a person who translates the user's needs into the builder's requirements. An architect must thoroughly understand the building and operational codes under which his or her design must conform. That degree of knowledge is necessary so that he or she is not apt to omit any necessary requirements, or produce improper, conflicting, ambiguous, or confusing requirements. He or she must understand the various methods available to the builder for building the client's structure, so that he or she can negotiate with the client to produce a best possible compromise of the results desired within explicit cost and time boundaries.

Architects are professionals who must frequently make building design and planning decisions that affect the safety and well being of the general public. Architects are required to obtain specialized education and documented work experience to obtain professional licensure, similar to the requirements for other professionals, with requirements for practice varying greatly from place to place.

An architectural designer is an architect that is primarily involved in the design of buildings or urban landscapes, as opposed to the construction documents and management required to construct it. Architectural Designers are individuals who should have good creative skills, imagination and artistic talent. Although most students of architecture are trained to be designers in school, not all become designers in practice. Non-registered designers are similar, but cannot legally refer to themselves as "architectural" designers in most parts of

the world. Most are referred to as building designers, especially when not employed by an architectural firm.

Many large architectural firms have architectural designers that set what the general public views as the "style" of the firm's projects. These firms may actually have groups of designers (design studios), often divided into their own separate niche markets (education, healthcare, housing, etc.) In smaller architectural firms, the architectural designers tend to remain involved with the project right through completion, and actually take an active role in documentation and management. It is worth noting that most "star" architects, that have become household names, are known because of their skill as architectural designers.

A landscape architect is a person, generally speaking, with an education, whether academic or practical, in landscape architecture and whose professional work conforms to the practice of the same name. The term landscape architect is used differently because professional licenses can be sought through registration examinations. This varies by country and state, for example some US states offer "practice acts" and some offer "title acts". Each refers to the limitations placed on persons who are and are not licensed.

The term landscape architect may also include figures who are better known as landscape gardeners, landscape designers, architects, surveyors or engineers, particularly those from the 18th century who practised before the term 'landscape architect' was coined. Landscape architecture was also differentiated as a

profession in the United States earlier than in other parts of the world so this ambiguity has persisted to the present day; in much of Europe, for example, landscape architecture is not a distinct profession but there are many significant historical and contemporary examples of 'landscape architectural' projects.

Discussion

1. What is architecture engineering?
2. What does planned architecture manipulate?
3. How can architecture be distinguished from applied science?
4. Mention the skills demanded of an architect, in the field of building architecture.
5. How may many architectural works be seen?
6. What is the role of the architect?
7. What are the principles that good buildings should satisfy?
8. What is the modern-day definition of architecture?
9. Why do we call architecture an interdisciplinary field?
10. How does Vitruvius see architecture?
11. What should an architect be, according to Vitruvius?
12. What is philosophy?
13. How did architecture first evolve?
14. Who constitute the early stage of architecture?
15. How did architecture turned into a craft?
16. What is vernacular architecture?
17. How were the early human settlements?
18. What did many ancient civilizations such as the Egyptians', architecture and urbanism reflect?
19. When did Islamic architecture begin?
20. Give examples of Islamic architecture?
21. What does Islamic architecture include?
22. What happened to architecture with the beginning of the Renaissance?
23. How did the consolidation of knowledge in scientific fields and the rise of new materials and technology affect architecture?

24. What was the effect of the Industrial Revolution upon architecture?
25. What did modern architect seek to do?
26. How did many people see Modernism?
27. Why was Postmodernism developed?
28. When did architecture start becoming more multi-disciplinary?
29. What is the definition of an architect?
30. In a technical sense, what are architects?
31. What does the term landscape architect include?
32. What is an architectural designer?

Linguistic Drills

An Architect

An *architect designs* and plans houses. There will always be a need for architects, because people will always need houses to live in. My brother wants to be an architect. He is 17 years old and has passed all his school examinations. Now he will have to take the entrance examination of an *Institute of Technology* where there is a course in Architecture. After three years' work he will sit for the *Intermediate* Examination in Architecture. When he has passed this, he will have to spend two or three years preparing for the Final Examination in Architecture.

When my brother becomes an architect, he will work in a well-lit and well-*ventilated* office. He will also have outdoor work. He will have to visit building *sites* to *supervise* the work there. If he enters government service as a *junior* architect he will have good hopes of *promotion,* because he is not afraid of hard work, and later, as a senior architect, he will receive a good salary.

1. Answer these questions:

a) Why will architects always be needed?
b) Where do students take courses in Architecture?
c) How long does the whole course last?

d) How many examinations must students pass before they qualify as architects?
e) Do architects only design and plan houses?
f) Why do architects have to visit building sites?

2. Fill the blanks with a or an if necessary:

a) ___ architect designs houses.
b) The course in ___ Architecture is ___ full-time one.
c) Students must pass ___ entrance examination before they can study at ___ Institute of Technology.
d) The course is ___ long one, lasting for five or six years.
e) __ architect works in ___well-ventilated office.

3. Begin this paragraph with *tomorrow* instead of *yesterday*, and rewrite it, making the necessary changes:

Yesterday there was a meeting of the Students' Union. The President did not come to the meeting, so the Vice-President had to act as Chairman. The Secretary read out the minutes of the previous meeting. Afterwards there was a discussion of suggestions made by members and a programme of activities for the rest of the year was drawn up. After the meeting the members present were entertained to tea by the Committee.

UNIT SIX

Electric power systems

Special terms

as . . . so . . .	*As* = in the same way as; at the same time as, while. This sentence means: 'while the power industry grows, economic problems. . . grow too'. Another example : '*As* the temperature increases, *so* does the volume of a gas at constant pressure.'
unique	Incomparable, unlike any other. (NOT single).
very instant	Precise moment. *(Very* here = precise, exact).
stored	Kept, conserved, held.
a balance must. . . be struck	*Strike a balance* = reach or arrive at a point midway between advantages and disadvantages. (Another example at 86. *Strike (struck, struck)* means *hit* - 'lightning struck the overhead line' .
breakers	Circuit breakers, switches.
bus bar	Short conductor forming a common junction between two or more circuits (US *bus,* plural *busses).*
grid system	Electrical network of 132 kV and 33 kV lines. In many parts of the world (particularly in the Soviet Union), even higher voltages are employed.

comprise	Include, consist of.
large-scale electricity generation	Generation of electricity on a large scale (i.e. in vast quantities).
conventional	Traditional (not of the latest type).
refuse [refju:s]	Rubbish, things of no value. (Compare *refuse*[refju:z], verb.)
none . . . has	Note singular verb: *none* = not one.
pilot-plant stage	The phase of experimentation in a trial *(pilot)* unit.
casing	Container.
nozzle	Projecting end of a tube or pipe from which a liquid or gas emerges under pressure.
condenser	Here steam condenser, apparatus for converting a Vapour to a liquid.
fission	Pronounced ['fijen].
head of water	Energy per unit weight of a fluid possessed due to its elevation, its velocity or its pressure.
prime mover	Engine or motor in which a natural source of energy is converted into mechanical power.
warming-up period	Interval during which equipment reaches full efficiency (i.e. *warms up*, reaches its working temperature).
standing losses	Costs of keeping plant ready but inactive.
load centre	Area of great consumption.
bulk supply	Supply in great quantity.
optimum voltage	When we reach an equilibrium between costs and savings, the voltage at that point is the most favourable (i.e. which costs least); it is the *optimum* voltage.
sub-station	Local transformer and distribution centre.
heavily urbanized areas	Localities where there are many buildings covering the ground.

less congested districts	Areas where there is more space between buildings.

Electric power systems

As *the power industry* grows, so do the economic and engineering problems connected with the generating, transmission and *distribution systems* used to produce and handle the vast quantities of electrical energy consumed today. These systems together form an electrical *power system.*

It is important to note that the industry that produces electrical energy is unique in that it manufactures its product at the very instant that it is required by the customer. Energy for the generation of electricity can be stored in the form of coal and oil, and of water in reservoirs and lakes, to meet future requirements, but this does not decrease the need *for generator capacity* to meet the customers' demands.

It is obvious that the problem of the continuity of service is very important for an electrical power system. No service can be completely protected from the possibility of failure and clearly the cost of the system will depend on its reliability. A balance must therefore be struck between reliability and cost; and the final choice will depend on the size of the load, its character, the source of possible interruptions and the user's requirements. However a net *reliability gain* is obtained by employing a certain number of generating units and by using automatic breakers for the separation into sections

of the *bus bars* in generating stations and of the *transmission lines* in a national or international *grid system.* In fact a large system comprises numerous generating stations and loads interconnected by *high-capacity transmission lines.* An individual unit of generation or set of transmission lines can usually cease to function without interrupting the general service.

The most usual system today for generation and for the general transmission of power is the *three-phase system.* In favour of this system are its simplicity and its saving with respect to other *a.c. systems.* In particular, for a given voltage between conductors, with a given power transmitted, with a given distance, and with a given *line loss,* the three-phase system requires only 75 per cent of the copper or aluminium needed in the *single-phase system.* Another important advantage of the three-phase system is that *three-phase motors* are more efficient than single-phase ones. The sources of energy for *large-scale electricity generation* are : steam obtained by means of a conventional fuel (coal, oil or natural gas), the combustion of *city refuse* or the employment of nuclear fuel; water ; *diesel power* from oil. There are other possible sources of energy such as direct solar heat, *wind power,* tidal power, etc., but none of these has yet gone beyond the *pilot-plant stage.*

In large *steam power plants,* the thermal energy stored in steam is converted into work by means of turbines. A turbine consists essentially of a shaft or rotor fixed in bearings and enclosed in a cylindrical casing. The rotor is made to turn smoothly by means of jets of steam from nozzles around the periphery of the *turbine cylinder.*

These *steam jets* strike blades attached to the shaft. Central *power stations* employ condensing turbines in which the steam passes into a condenser after leaving the turbine. Condensation is effected by the circulation of large quantities of cold water through the tubes of the condenser, thus increasing the *expansion ratio* of the steam and the consequent efficiency and *work output* of the turbine. The turbines are connected directly to large *electricity generators.*

In turbines the action of the steam is kinetic. There is progressive expansion of the steam from the high pressure and relatively small volume at which it enters the turbine to the low pressure and relatively very great volume at which it leaves.

Steam is made by heating water in a boiler. The usual boiler has a furnace in which fuel is burned, and the heat given off during combustion is conducted through the *metal walls* of the boiler to generate steam at a pressure within the *boiler vessel.* In nuclear plants, steam is generated with the aid of a reactor in which the controlled fission of uranium or plutonium supplies the necessary heat for the vaporization of water. Thus the reactor replaces the *steam generator* of conventional plants.

Use is made of the energy possessed by water in hydroelectric stations. In order to transform this energy into work, hydraulic turbines are used. Modern hydraulic turbines may be divided into two classes: *impulse turbines* and *pressure* or *reaction turbines.* Of the former, the *Pelton wheel* is the only type used in important

installations; of the latter, the *Francis turbine* or one of its modifications is universally employed,

In an impulse turbine, the whole head of water is converted into kinetic energy before the wheel is reached, as the water is supplied to the wheel through a nozzle. In the pressure or reaction turbine the wheel (or runner) is provided with vanes into which water is directed by means of a series *of guide vanes* around the whole periphery. The water leaving these guide vanes is under pressure and supplies energy partly in the
kinetic form and partly in *the pressure form.*

The *diesel engine* is an excellent prime mover for electricity generation in plant below about 10,000 kVA. It has the advantage of low *fuel cost,* a brief *warming-up period* and low *standing losses.* Moreover it requires little *cooling water. Diesel generation* is generally chosen for small *power requirements* by municipalities, hotels and factories; hospitals often keep an independent *diesel generator* for *emergency supply.*

The transmission of electrical energy by means of lines is a great problem in electrical power systems. Transmission lines are essential for three purposes :

1 To transmit power from a hydroelectric site to a *load centre* perhaps a considerable distance away;

2 For the *bulk supply* of power from *steam stations* to load centres a relatively short distance away;

3 For *interconnection purposes* to transfer energy from one system to another in case of emergency.

The *transmission voltage* is determined largely by economic factors. In fact, in a transmission line, if the distance, the power and *the power loss* are fixed, the total weight of the conductor varies inversely as the square of the transmission voltage. For the economic transmission of power over considerable distances the voltage must therefore be high. Naturally with higher voltages the *insulation cost* also rises and to find the *optimum voltage* we must strike a balance between this cost and the saving through the reduction of the cross-section of the conductors.

For high voltages, *overhead-line construction* is generally used with *suspension-type insulators. Steel towers,* called pylons, serve to carry the insulators, with each conductor suspended from the bottom of a group or string of *insulator units.* The following types of conductor are those most commonly used: stranded *copper conductors,* hollow copper conductors and *ACSR (aluminium cable, steel reinforced) conductors.*

Distribution includes all the parts of the *electricity system* between *the power sub-stations* supplied from high-voltage transmission lines and the consumer's switch. Electric power is received from sub-stations and distributed to the consumers at the *voltage levels* and with the degree of continuity that are acceptable to the various types of consumer. In large metropolitan systems both overhead and underground *distribution methods* are used. Although *underground distribution* is more expensive than an *overhead system,* it is virtually a necessity in heavily urbanized areas. In smaller towns and in the less

congested districts of large cities, the entire *distribution system* is usually overhead.

Discussion

True or false

1 Generator capacity below consumption requirements can be increased by having bigger stores of coal and water.
2 Three-phase motors are more efficient than single-phase ones.
3 The combustion of city refuse for large-scale electricity generation has not yet gone beyond the pilot-plant stage.
4 The rotor in a steam turbine is made to turn smoothly by water supplied through nozzles.
5 To increase the expansion ratio of steam in central power station steam generators, the steam passes into condensers after leaving the turbine.
6 Both the action of steam in a turbine and the action of water in an impulse turbine are kinetic.
7 There are three classes of modern hydraulic turbine: impulse, pressure and reaction.
8 The Francis turbine is of the pressure type.
9 In a reaction turbine, energy is supplied by the water both in the kinetic and in the pressure form.
10 Diesel generation is more economical above 10,000 kVA than below.
11 The highest transmission voltage used is 132,000 volts.
12 The total weight of a conductor varies directly as the square of the transmission voltage if the distance, power and power-loss are kept constant.
13 As the voltage rises, so does the insulation cost.
14 Overhead distribution is less expensive than underground distribution.

15 A stranded aluminium conductor is one of the three most commonly used types.

Linguistic Drills

Nouns used as adjectives

Considerable use in technical writing is made of nouns qualifying other .nouns. In unit six, at least 65 different noun-plus-noun combinations *(printed in italic type)* are used. A better understanding may be had of noun-plus-noun combinations by examining different reasons for preferring a noun rather than an adjective as the qualifying word.

1. No adjective may be available.

boiler vessel	vessel forming the boiler
emergency supply	supply for use in an emergency
fuel cell	cell consuming fuel
steam jets	jets of steam
turbine cylinder	cylinder of the turbine
wind power	power from the wind
overhead line construction	construction of a line that is elevated (i.e. overhead)
generator power output voltage	the voltage of the output of the power from the generator
a.c. system	system of alternating current
supply voltage	voltage of the supply
voltage supply	supply or source of voltage

2. The adjective may not be sufficiently precise for technical writing.

pole face	face of the pole (not *polar)*
electron charge	charge of an electron (not *electronic)*
electronic) cylinder wall	wall of the cylinder (not *cylindrical)*
instrument response	response of the instrument (not *instrumental)*
sphere gap	gap between two metal spheres (not *spherical)*
line amplifier	output amplifier supplying power to the line (not *linear)*
crystal oscillator	oscillator employing piezoelectric crystal (not *crystalline)*

3. Noun-plus-noun may give a more modern or graphic image than the equivalent adjective.

atom bomb	atomic bomb (the original form was *atomic*; *atom* is shorter)
city refuse	urban refuse (less abstract)
convection effect	convectional effect
electricity generation	electric generation (avoids choice between *electric* and *electrical)*
heat energy	thermal energy (less pedantic)
metal plate	metallic plate (shorter, easier to say)
peak value	highest value (the curve on the graph forms a peak)
sponge lead	spongy lead *(sponge* better describes the appearance, *spongy* the soft consistency)

4. Proper nouns used adjectivally are simpler to use than the possessive form.

diesel engine	(note loss of capital letter)
Francis turbine	
Hartley oscillator	(but *Colpitt's oscillator)*
Joule effect	*(but Joule's law)*

Pelton wheel
Wheatstone bridge

Notes

1. Nouns used adjectivally are almost never in the plural form, even when they convey a plural idea.

computer data	data for computers
domain axes	axes of the domains
instrument case	case containing instruments
load centres	centres where loads occur
pole faces	faces of the poles
pulse chain	chain of pulses
four-pole machine	electric machine with four poles
three-phase system	system employing three phases of power

Some exceptions:

data processing	computer processing of data (sing, *datum)*
exports division	company division responsible for exports
men students	students who are men. (The singular form *man student* is also used. Also *woman/women* *students.)*
systems analysis	analysis of organizational systems leading to the writing of a computer program

2. Some noun-plus-noun combinations have become words in their own right and are written as one word or as two words joined by a hyphen. Shorter combinations more easily become single words; longer combinations, or those which would be ugly as a single word, are preferably hyphenated. The whole problem is, however, open to personal taste, and dictionaries differ as to whether a given combination is one word, hyphenated or two

separate words. One guide to the form to adopt is the stress in the combination: for a combination to be written as a single word or a hyphenated form it usually has single stress. Unfortunately the converse of this statement is not true, and many two-word combinations exist with single stress.
If in doubt use two words.

coalfield but *oilfield*
manpower
metalwork
powerhouse
railway but *cable-way*
steamship
toolbox
waterpower
workbench
workman
workshop
air-gap
circuit-breaker
lift-motor
light-year
oil-switch
switch-box
water-gauge

Exercises

A. Which? What? or Who?

All these questions begin with which, what or who. First decide which one of the three question words is correct, and then answer the questions.

1 ____ proposed the two rules relating the flux, motion and e.m.f. of a current ?
2 ____ of the following two turbines is an impulse turbine: the Pelton wheel, the Francis turbine?
3 ____ is the frequency of the power systems in the USA?
4 ____ is the better conductor, copper or silver?

5 ____ was Hertz ?
6 ____ is a hertz ?
7 ____ is the opposite of include ?
8 ____ gave his name to the unit of magnetic flux ?
9 _____is longer, a mile or a kilometer?
10 _____ letter of the Greek alphabet indicates magnetic permeability?

B. Spelling

Complete the words in the following passage so as to spell them correctly.

Perman_ magn_t moving coil instruments are emplo_d to m_ure direct cur_s and v_lt_ges. The basic princip_ is that of a r_tat_ng c_l with a_ached indicat_ turning in the f_ld of a perman_ magn_t specia_y d_s_ned so that the ang_ar respon_ of the moving s_st_m is uniform and the cal_br_on of the instrument does not change in time due to changes in the val_ of the f_ld. To m_ cur_ val_s ab_ve 20 mi_amperes (which w_d cause overh_ting in a simple instrument), a sh_nt resis_ is used with a mi_am_ connected in par_l.

Introductory it

Replace the expressions in italics by equivalent forms using the construction it is (not) + adjective + to . . ., as in the following example.

Example

- In a mathematical treatment of non-sinusoidal waves *we can employ* sinusoidal functions.
- In a mathematical treatment of non-sinusoidal waves it *is possible to employ* sinusoidal functions.

1 In order to compare the resistance of different materials, *we usually state* the resistance offered by a cube having a side of 1 centimeter.
2 Tables of specific resistances usually assume a temperature of 0° Centigrade and for accurate

calculations *we need to make* a correction according to the working temperature.

3 If we know the specific resistance of a substance, *we can easily calculate* the resistance of any conductor made of that substance.

4 In commercial electro-plating work *we often desire* to deposit first one metal and then another to obtain a satisfactory coating.

5 *We find it difficult to obtain* very pure zinc.

6 There is no magnetic insulator, but when *we need to keep* magnetic flux away from some component a path of low reluctance can be provided to take away much of the flux.

7 *We easily calculated* the number of amperes.

8 *We cannot usefully employ* an electrolytic capacitor when the applied e.m.f. is in either direction.

9 *We shall prefer to adopt* hollow copper conductors in these particular circumstances.

10 *We must have* an underground distribution system in all heavily urbanized areas.

Summary

To obtain the required degree of continuity of service a balance must be struck between reliability and cost. A reliability gain is obtained by using numerous generating stations with loads interconnected by high-capacity transmission lines. Three-phase generation is generally used and steam, water and diesel oil are the main energy sources. Turbines convert the kinetic energy in steam into work. Steam is obtained by heating water in a boiler using a conventional fuel or by the vaporization of water in a nuclear reactor. Hydroelectric stations use impulse or reaction turbines to transform the energy in falling water into work. Diesel plants are excellent for generation below 10,000 kVA.

Electrical transmission lines transmit electricity from the point of generation to the market; or they may interconnect two or more systems. Power is transmitted economically over long distances using high voltages with overhead lines. Transforming to voltage levels suitable to the consumers takes place at substations which with the overhead or underground distribution lines form the distribution system.

UNIT SEVEN

ELECTRICAL AND ELECTRONIC ENGINEERING IN THE FUTURE

Special Terms

Elementary Particles: The basic components of all matter and energy not known to be combined with any other thing and believed to be incapable of subdivision.

Pulsars: Astronomical objects that emit radio waves in pulses whose rates are extremely uniform. The word comes from puls(ating) and (st)ar.

Quasars: Very distant, celestial objects that are strong radio sources with vast, unexplained energy outputs. The word comes from quas(i) and (stell)ar, meaning "like a star."

Inertial Guidance: The determination of the position or course of a ship or missile by self-contained automatic devices which detect change in direction or speed and make necessary adjustments; also called *inertial navigation.*

Hypersonic: Refers to speeds five times or greater than the speed of sound.

Cybernetics: The science of automatic controls.

Robot: An apparatus in the form of a human being that performs the mechanical functions of humans in a way that seems to show intelligence.

Information Theory: Mathematical analysis of the efficiency with which computers, telecommunication channels, and other information processing systems are employed.

Research and Development: Investigation and experimentation by scientists, engineers, and technicians aiming for better understanding of physical laws and the development of practical systems based on such findings; often called RυD.

Antennae: Exposed arrangements of wires and rods which radiate and/or receive electromagnetic waves.

Filter: A device which discriminates between waves and currents, permitting the passage of some and limiting the flow of others.

Transducer: Any device which converts one form of energy to another form of energy.
Relay: An electrically operated device that opens and closes electric switches or other devices in an electric circuit.

Electrical and Electronic Engineering in the Future

So much of the development of science and technology depends on the variables of economic, political, and social developments that precise predictions about future trends in the field of electrical and electronic engineering cannot be made. But it is possible to discern certain technological trends which can reasonably be expected to occur.

Experts on the future are divided into pessimists and optimists. Pessimists forecast doom. They point to increasing pollution of the atmosphere, water, and land, the depletion of raw materials, the exhaustion of some now-common energy sources, and the geometric expansion of population.

Optimists foresee unlimited energy through harnessing the power of the atom, the discovery of new and unlimited food sources, and the dawn of an age in which human drudgery is replaced by technological advances. The truth is probably somewhere in between.

A major scientific advance such as the development of a comprehensive theory and knowledge of *elementary particles,* the basic components of all

matter and energy, could profoundly change the way we live tomorrow. A theory based on knowledge of such strange objects as *pulsars,* stars that emit radio waves in uniform pulses, and *quasars,* strong radio sources and unexplained sources of enormous energy could alter life in ways we cannot yet forecast.

Electrical and electronic scientists and engineers are engaged in examining and developing these areas. They are not restricted in their exploration to our present knowledge of space or time. With an instrument known as an electron accelerator, they probe the mysteries of the atomic nucleus, and with the radio telescope they study signals from remote regions of outer space. With computers they can store information indefinitely and with electronic circuits they can get information in a thousand-billionth of a second.

A major success such as the harnessing of thermonuclear energy produced through nuclear fusion would radically affect the development of all branches of engineering. The world would move from a state of energy scarcity to an era of inexhaustible energy resources. Given the proper economic and political circumstances, this would cause tremendous growth in science and technology.

In any case, the future of electrical and electronic engineering does not depend solely on the development of new scientific theories or the discovery of new energy sources. These engineers will be engaged in diverse technological pursuits such as the following:

Electrical and electronic engineers will be intimately involved in the development of the completely automated industrial factory. It will become possible, with the aid of electronic computers, to produce goods by teams of machines that transfer materials from one to another. In such a factory a product could be manufactured, tested, labeled, packaged, and shipped without being touched by human hands or directed by human intellect.

In the field of transportation, electrical engineers are currently engaged in developing the electric automobile, train, bus, and ship. They are designing new *inertial guidance* systems which would guide rockets and interplanetary spaceships by using devices which detect changes in speed and direction and make necessary adjustments automatically.

Fueling aircraft and spacecraft by laser beam is another possibility that will transform future travel. As light energy can be converted into other forms of energy, so could the laser beam be converted to aircraft fuel. Such a breakthrough would greatly reduce the weight of aircraft and thereby increase the probability of *hypersonic* travel-travel at speeds five or more times greater than the speed of sound. Planes could travel at 4,000 to 5,000 miles an hour and at altitudes of 150,000 feet.

Society will become more and more computerized, and the electronic engineer will be called upon to design and build ever-smaller computers capable of doing more varied and more complicated tasks. At some time in the future, fully automatic automobiles and homes will be

built and directed by computers. Computers that "think," that learn from errors and never make the same mistake twice, that are able to repair themselves and reproduce themselves, may be the reality of tomorrow.

Cybernetics, the science of automatic controls, could eventually produce a race of *robots*-machines in human shapes that perform human tasks with what parallels human intelligence. Only human sensitivity, emotion, and sexuality will be missing. The necessary scientific knowledge for building these labor-replacing devices is available to engineers today: computer technology, microcircuit technology, control theory, and *information theory-a.* Mathematical analysis of the efficiency with which computers, telecommunication channels, and other information-processing systems are employed. The electronic engineer need only translate today's knowledge into tomorrow's machinery.

The exciting field of biomedical engineering offers enormous possibilities. More and more electronic instruments to extend, repair, and improve upon physical life are currently being developed. Lasers are already used to join living tissues such as detached eye retinas; their uses in surgery too intricate and delicate for the knife will become commonplace. Computers will be developed to diagnose and treat disease. Electronic engineers will devise more usable and varied organs and organ replacements. There is, theoretically, no limit to the uses of electronics in medicine.

Not only will the new developments make use of the electronic engineer; he or she will develop new

electronic products for people to buy. Telephones with picture screens on which the connected parties can see each other and three-dimensional television which would completely envelop the viewer could become ordinary household items.

Research and development, or *R &* D – investigation and experimentation by scientists, engineers, and technicians - is not confined to sciences such as physics or radio astronomy. Countless engineers will continue to design and improve upon existing vacuum tubes, switches, and electromechanical devices. Improvements will be made in *antennae,* arrangements of wires and rods which fan out to receive electromagnetic waves; *filters,* which block out selected waves or current; *transducers,* which convert one form of energy to another; and *relays,* which electrically cause switches in a circuit to open and close. These are the basic components of the electronics industry and a vital segment of the industries that maintain our economy.

These exciting possibilities indicate a bright future for electrical and electronic engineers. They will play a central role in formulating, shaping, and bringing into being the immediate and distant future.

Discussion

1. What factors make it especially difficult to predict the future development of science and technology?
2. Describe a pessimistic view of the future. Describe an optimistic view of the future.
3. What do we know about pulsars? Quasars?

4. What instrument is available for probing the atomic nucleus?
5. What instrument is used for receiving signals from outer space?
6. How long can a computer store information?
7. How fast can an electronic circuit act?
8. What changes might occur if thermonuclear energy were harnessed for use?
9. What would have to be improved in order to properly use a new source of energy?
10. How would a completely automated industrial factory work?
11. Why would inertial guidance be an advantage for interplanetary travel?
12. How would fueling aircraft with laser beams change travel?
13. In what sense may computers "think" in the future?
14. What science could produce a race of robots?
15. What scientific knowledge is available today which would contribute to building robots?
16. How is electronics used in the field of medicine today? What contributions will electronics make in the future?
17. What new electronic products will we be able to buy?
18. What basic components of the electronics industry will be improved in the future?

Review

Complete the following sentences by writing in a word or phrase.

1. Experts on the future are divided into _______________ and _______________.
2. _______________ are stars that emit uniform radio waves.
3. Computers can store _______________ indefinitely.
4. In a fully automated factory, products could be manufactured, _______________, _______________, packaged

and ______________ without being touched by human hands.

5. Fueling aircraft and spacecraft by ______________ would greatly reduce their weight.
6. Computers will become ______________ and able to do ______________________________ tasks.
7. Robots will be able to perform ______________ tasks with what seems like human ______________.
8. In the field of medicine, ______________ will be used for surgery too delicate for the knife.
9. R&D will continue to deal with existing electronic components such as ______________, ______________, ______________, and ______________.
10. The future of electrical and electronic engineering seems ______________________________

UNIT EIGHT

Environmental engineering

Special Terms

Science in the broadest sense refers to any knowledge or trained skill, especially (but not exclusively) when this is attained by verifiable means. The word science also describes any systematic field of study or the knowledge gained from such study.

The natural environment comprises all living and non-living things that occur naturally on Earth. In its purest sense, it is thus an environment that is not the result of human activity or intervention. The natural environment may be contrasted to "the built environment."

Remediation in terms of new media, is the representation of one medium in another.

Engineering is the application of scientific and technical knowledge to solve human problems. Engineers use imagination. judgment and reasoning to apply science, technology, mathematics, and practical experience. The result is the design, production, and operation of useful objects or processes.

Pollution is the release of chemical, physical, biological or radioactive contaminants to the environment. Principal forms of pollution include:

- air pollution, the release of chemicals and particulates into the atmosphere.

- water pollution affects oceans and inland bodies of water. Examples include organic and inorganic chemicals, heavy

metals, petrochemicals, chloroform, and bacteria. soil contamination often occurs when chemicals are released by spill or underground storage tank leakage. radioactive contamination, added in the wake of 20th-century discoveries in atomic physics. noise pollution, which encompasses roadway noise, aircraft noise, industrial noise as well as high-intensity sonar. light pollution, includes light trespass, over-illumination and astronomical interference.

- visual pollution, which can refer to the presence of overhead power lines, highway billboards, scarred landforms (as from strip mining), open storage of junk or municipal solid waste.

An **aqueduct** is an artificial (man-made) channel that is constructed to convey water from one location to another. The word is derived from the Latin aqua, "water," and ducere, "to lead." Many aqueducts are raised above the landscape, resembling bridges rather than rivers.

A **metropolitan area** is a large population center consisting of a large city and its adjacent zone of influence, or of several neighboring cities or towns and adjoining areas, with one or more large cities serving as its hub or hubs.

Sewers transport wastewater from buildings to treatment facilities. Sewers are pipelines that connect buildings to horizontal 'mains'. The sewer mains often connect to larger mains, and then to the wastewater treatment site. Vertical pipes, called manholes, connect the mains to the surface. Sewers are generally gravity powered, though pumps may be used if necessary.

Sewage (or domestic wastewater) treatment incorporates physical, chemical and biological processes which treat and remove physical, chemical and biological contaminants from water following human use. The objective of the treatment is to produce both a clean wastestream (or treated effluent) suitable for discharge or reuse back into the environment, and a solid waste or sludge also

suitable for proper disposal or reuse. This material is often inadvertently contaminated with toxic organic and inorganic compounds.

Sewage is the watery waste type produced by human society which typically contains washing water, laundry waste, faeces, urine and other liquid or semi-liquid wastes. It is one form of wastewater.

Cholera (also called **Asiatic cholera**) is a water-borne disease caused by the bacterium Vibrio cholerae, which are typically ingested by drinking contaminated water, or by eating improperly cooked fish, especially shellfish.

DDT was the first modern pesticide and is arguably the most well known organic pesticide. It is a highly hydrophobic colorless solid with a weak, chemical odor that is nearly insoluble in water but has a good solubility in most organic solvents, fat, and oils.

Agriculture (a term which encompasses **farming**) is the art, science or practice of producing food, feed, fiber and many other desired goods by the systematic raising of plants and animals.

Rachel Louise Carson (May 27, 1907 – April 14, 1964) was a Pittsburgh, Pennsylvania-born zoologist and marine biologist whose landmark book, Silent Spring, is often credited with having launched the global environmental movement.

Silent Spring was written by Rachel Carson and published in September, 1962. The book is widely credited with launching the environmentalism movement in the West.

The Conservation Movement is a political and social movement that seeks to protect natural resources including plant and animal species as well as their habitat for the future.

Law is the set of rules or norms of conduct which forbid, permit or mandate specified actions and relationships among people and organizations.

Habitat is the place where a particular species lives and grows. It is essentially the environment—at least the physical environment—that surrounds (influences and is utilized by) a species population.

In botany, **flora** (plural: floras or florae) has two meanings. The first meaning, or flora of an area or time period, refers to all plant life occurring in an area or time period, especially the naturally occurring or indigenous plant life. The second meaning refers to a book or other work which describes the plant species occurring in an area or time period, with the aim of allowing identification.

Fauna is a collective term for animal life of any particular region or time. The corresponding term for plants is flora. Flora, fauna and other forms of life such as fungi are collectively referred to as biota.

A drainage basin (also known in North America as a **watershed**) is a region of land where water from rain or snowmelt drains downhill into a body of water, such as a river, lake, dam, estuary, wetland, sea or ocean. The drainage basin includes both the streams and rivers that convey the water as well as the land surfaces from which water drains into those channels.

Irrigation is the replacement or supplementation of rainfall with water from another source in order to grow crops or plants. In contrast, agriculture that relies only on direct rainfall is sometimes referred to as dryland farming.

Hydrology is the study of the movement, distribution, and quality of water throughout the Earth, and thus addresses both the hydrologic cycle and water resources. A practitioner of hydrology is a hydrologist, working within the fields of either earth or environmental science, or civil and environmental engineering.

Water resources are sources of water that are useful or potentially useful to humans. It is important because it is needed for life to exist. Many uses of water include agricultural, industrial, household, recreational and environmental activities. Virtually all

of these human uses require fresh water. Only 3% of water on the Earth is fresh water, and over two thirds of this is frozen in glaciers and polar ice caps.

An outhouse, privy or **kybo** is an old type of toilet in a small structure separate from the main building which does not have a flush or sewer attached.

A **septic tank** also known as a **septic system** is a small scale sewage treatment system common in areas with no connection to main sewerage pipes.

A **honey bucket** is a bucket that is used in place of a flush toilet in communities that lack a water borne sewerage system. The honey bucket sits under a wooden frame affixed with a toilet seat lid. The honey bucket gets its name from the actual five–gallon (19 litre) buckets which were once used as containers for honey.

Environmental engineering

Environmental engineering is the application of science and engineering principles to improve the environment (air, water, and/or land resources), to provide healthful water, air and land for human habitation and for other organisms, and to investigate the possibilities for remediation of polluted sites. Negative environmental effects can be decreased and controlled through public education, conservation, regulations, and the application of good engineering practices.

Ever since people first recognized that their health and well-being were related to the quality of their environment, they have applied thoughtful principles to attempt to improve the quality of their environment. The

Romans constructed aqueducts to prevent drought and to create a clean, healthful water supply for the metropolis of Rome. In the 15th century, Bavaria created laws restricting the development and degradation of alpine country that constituted the region's water supply.

Modern environmental engineering began in London in the mid-19th century when it was realized that proper sewerage could reduce the incidence of waterborne diseases such as cholera. The introduction of drinking water treatment and sewage treatment in industrialized countries reduced waterborne diseases from leading causes of death to rarities.

In many cases, as societies grew, actions that were intended to achieve benefits for those societies had longer-term impacts which reduced other environmental qualities. One example is the widespread application of DDT to control agricultural pests in the years following World War II. While the agricultural benefits were outstanding and crop yields increased dramatically, thus reducing world hunger substantially, and malaria was controlled better than it ever had been, numerous species were brought to the verge of extinction due to the impact of the DDT on their reproductive cycles. The story of DDT as vividly told in Rachel Carson's "Silent Spring" is considered to be the birth of the modern environmental movement and the development of the modern field of "environmental engineering."

Conservation movements and laws restricting public actions that would harm the environment have been developed by various societies for millennia.

Notable examples are the laws decreeing the construction of sewers in London and Paris in the 19th century and the creation of the U.S. national park system in the early 20th century. Briefly speaking, the main task of environmental engineering is to protect (from further degradation), preserve (the present condition), and enhance (the environment).

"Pollutants" may be chemical, biological, thermal, radioactive, or even mechanical. Environmental engineering emphasizes several areas: process engineering, environmental chemistry, water and wastewater treatment (sanitary engineering), waste reduction/management, and pollution prevention/cleanup. Environmental engineering is a synthesis of various disciplines, incorporating elements from the following: Civil engineering, Public health, Geology, Chemical engineering,Chemistry, Mechanical engineering, Biology, Ecology.

Environmental Engineering is the application of science and engineering principles to the environment. Engineers and scientists assess the impacts of a proposed project on environmental conditions. They apply scientific and engineering principles to evaluate if there are likely to be any adverse impacts to water quality, air quality, habitat quality, flora and fauna, agricultural capacity, traffic impacts, social impacts, ecological impacts, noise impacts, visual(landscape) impacts, etc. If impacts are expected, they then develop mitigation measures to limit or prevent such impacts. An example of a mitigation measure would be the creation of wetlands in a nearby location to mitigate the filling in of wetlands

necessary for a road development if it is not possible to reroute the road.

Engineers and scientists work to secure water supplies for potable and agricultural use. They evaluate the water balance within a watershed and determine the available water supply, the water needed for various needs in that watershed, the seasonal cycles of water movement through the watershed and they develop systems to store, treat, and convey water for various uses. Water is treated to achieve water quality objectives for the end uses. In the case of potable water supply, water is treated to minimize risk of infectious disease transmittal, risk of non-infectious illness, and create a palatable water flavor. Water distribution systems are designed and built to provide adequate water pressure and flow rates to meet various end-user needs such as domestic use, fire suppression, and irrigation.

There are numerous wastewater treatment technologies. A standard wastewater treatment train would typically consist of a primary clarifier system to remove solid and floating materials, a secondary treatment system consisting of an aeration basin followed by flocculation and sedimentation or an activated sludge system and a secondary clarifier, a tertiary biological nitrogen removal system, and a final disinfection unit. The aeration basin/activated sludge system removes organic material by growing bacteria (activated sludge). The secondary clarifier removes the activated sludge from the water. The tertiary system is becoming more prevalent to remove nitrogen and phosphorus and

disinfect the water before discharge to a surface water stream or ocean outfall.

Discussion

1. What does environmental engineering mean?
2. How can negative environmental effects be decreased?
3. What did people do when they recognized that their health and well-being were related to the quality of their environment?
4. Why did the Romans construct aquaducts?
5. How did modern environmental engineering begin?
6. How did the growth of societies bring harm to the environment? Give examples.
7. What is the main task of environmental engineering?
8. What are the different kinds of pollutants?
9. What disciplines does environmental engineering incorporate?
10. Why do Engineers and scientists evaluate the water balance?
11. Why is water treated ?
12. What are water distribution systems designed for?
13. What does a standard wastewater treatment consist of?
14. What does a secondary Clarifier do?

Linguistic Drills

The Pen and Its Ancestors

Man has never been satisfied with simply talking. For some reason he has always considered his words and ideas to be so important that he has always tried to find ways to record them on paper. Not only has man developed many systems of writing, he has also developed various tools with which to write.

One of the first instruments developed by man for writing was the stylus. It was a sharp instrument made of bone or metal, and with it the writer could scratch a message onto stone or wood. It was used for thousands of years and was very practical. The idea of using pen and ink was developed by the Egyptians. Their version of

the pen was made from bamboo. They sharpened one end of the stem to make a nib, that is, the point with which you actually write. Then they filled the hollow part of the stem with ink and squeezed it to force the ink onto the nib. It was a good idea, but when paper was later introduced, a much finer instrument was needed.

The problem was solved with the introduction of the quill pen. The quill is a large feather from the wing or tail of a swan or goose. The quill also gave us the word *pen* — feather in Latin is *penna.* Because this pen was a feather, however, it had to be sharpened quite often. A special instrument was made for this purpose, the penknife. The quill was used from the 6th through the 18th century, but in the 19th century a machine was invented which successfully made a nib out of metal. The nib could then be fitted into a holder and dipped into a bottle of ink. Finally, in 1884, a young American, Lewis Waterman, found a way of putting the ink into the holder, and the fountain pen as we know it was complete.
Although the fountain pen was very popular, a more popular kind of pen was introduced in 1943. This was the ball-point pen, invented by Laszlo Bfro, an Argentinian.

Comprehension Questions.

1.Man has been interested in writing ____________

a. only recently
b. for thousands of years
c. since he discovered the quill pen
d. since he learned how to make paper

2. The quill pen was better than the stylus because people could ________

a. kill their enemies with it
b. force the ink through into the nib
c. write more finely on paper
d. make clear signs on wood or stone

3. The penknife was first used to ____________

a. cut bamboo
b. keep the end of the quill sharp
c. cut feathers off a goose
d. cut the tail off a swan

4. A nib made from metal was an advantage because __________
a. it didn't need to be sharpened
b. the pens couldn't be filled with ink
c. you could use bottles of ink more easily
d. it made the pen much lighter

Answer the questions with complete sentences.

5. Who made the very first version of the fountain pen?

____

6. What were the disadvantages of the quill pen?

____

7. Who made the ballpoint pen?

____

Vocabulary

Choose the best meaning for the word in italics. Then write your own sentence using the word.

1. He did not give a *reason* for quitting his job. ____________
a. the cause or basis for an action
b. a notice in advance
c. the source of employment
d. the salary earned during a certain period

2. They were not *satisfied* with the results of the test. __________
a. unhappy b. happy c. considering d. sad

3. An early *version* of the pen was the stylus. _______________
a. weapon b. tool c. instrument d. variant

4. The *hollow* part of the stem was filled with ink. ____________
a. empty b. solid c. large d. bottom

5. If you *squeeze* the bottle, the liquid will come out. _________
a. put down b. throw c. pick up d. apply pressure to

6. After the instrument was put together, it was *complete.* ______
a. fitted b. dipped c. whole d. put

Here are some of the words from the text that you already know. Explain in your own words what they mean.

7. *message* Peter called while you were out, but he's left a message.

8. *practical* This penknife is very practical.

9. *solve* Nobody could solve the problem.

10. *popular* Pocket calculators are very popular these days.

11. *develop* The Americans have developed a new car engine.

Language

1. Record (line 3) is stressed record as a noun but re-cord' as a verb. Which of the following words follows the same pattern? ______
a. exchange b. reply c. notice d. protest e. arrest

2. Which one of the following *-ing* forms is used in the same way as *writing* (line 4)? __________
a. I thought of buying some new shoes.
b. The article was terribly boring.
d. Who's coming with us tonight?
c. The book lying on the table is mine.
e. After hearing the song, I decided to buy the record.

3. Which one of the following has the same stress pattern as *instrument?* __________
a. developed b. satisfied c. invented d. successful
e. introduced

4. In which one of the following sentences is *for* used in the same way as in line (6)? __________
a. A knife is for cutting things with.
b. There's a letter for you.
c. I've been waiting for hours.
d. Come on, well be late for the meeting,
e. He apologized for coming late.

5. In which one of the following sentences is *made* used in the same structure as in " . .. made of bone or metal"? __________
a. The statue is made out of wood.
b. My guitar was made in Spain.
c. Objects made here used to be good.
d. He made me go back at 6 o'clock,
e. These cups are very nice. Who made them?

6. *One* (line 6) refers to __________.
a. it b. wood c. instrument d. stylus e. message

7. In which one of the following words is *ea* pronounced in the same way as *in feather?*
a. cream b. bear c. beat d. dear e. dead

8. Which one of the following has feathers?
a. a chicken b. a cow c. a chimpanzee d. a lion
e. a mouse

Appositional Constructions

- One end was sharpened to make a nib, that is, the point with which you write. A special instrument, the penknife, was made to sharpen feathers.

Combine the sentences using appositives. Punctuate the sentences.

1. The problem was solved by the quill. The quill is a large feather from a swan or goose.

2. A new pen was introduced, which became very popular. This was the ball pen.

3. Man developed the stylus. The stylus was a sharp instrument made of bone or metal.

word formation

Complete the Chart.

Verb	*Adjective*	*Noun*
develop	*developed*	*development*
	popular	
force		
	satisfied	
	complete	

UNIT NINE
Biomedical engineering

Special Terms

Health care or **healthcare** is the prevention, treatment, and management of illness and the preservation of mental and physical well-being through the services offered by the medical, nursing, and allied health professions. The organised provision of such services may constitute a health care system.

Mechanical engineering is a very broad field that involves the application of physical principles for analysis, design, manufacturing, and maintenance of mechanical systems. It is made up of a number of subdisciplines concerned with the mechanics, kinematics (movement), and energy of physical objects.

In medicine, a **prosthesis** is an artificial extension that replaces a missing body part. Prostheses are typically used to replace parts lost by injury (traumatic) or missing from birth (congenital) or to supplement defective body parts.

A **medical device** is an instrument, apparatus, implement, machine, contrivance, implant, in vitro reagent, or other similar or related article, including a component part, or accessory.

A **medication** is a licenced **drug** taken to cure or reduce symptoms of an illness or medical condition.

A **Clinical engineer** is "a professional who supports and advances patient care by applying engineering and managerial skills to healthcare technology." Cross-disciplinary activities are the norm, often involving physicians, nurses, medical technologists, information technology professionals. pharmacists, administrators,

medical device manufacturer sales and engineering, and local and national regulatory authorities.

A **Biomedical Equipment Technician** (BMET) is a vital component of the healthcare delivery system. Employed primarily by hospitals, BMETs are the people responsible for maintaining a facility's medical and patient care equipment.

Computer software (or simply **software**) is the programs that enable a computer to perform a specific task, as opposed to the physical components of the system (hardware).

In the most general sense, **verification** is the establishment of the veracity (truth) of something, it can be a claim, a state of affairs, an employer or a computer program. Therefore it is performed in different manner and contexts.

Sterilization (or **sterilisation**) is the elimination of all transmissible agents (such as bacteria, prions and viruses) from a surface, a piece of equipment, food or biological culture medium. This is different from disinfection, where only organisms that can cause disease are removed by a disinfectant.

Magnetic resonance imaging (MRI), formerly referred to as magnetic resonance tomography (MRT) or nuclear magnetic resonance (NMR), is a method used to visualize the inside of living organisms as well as to detect the composition of geological structures.

X-rays are a form of electromagnetic radiation with a wavelength in the range of 10 to 0.01 nanometres, corresponding to frequencies in the range 30 to 30 000 PHz (10^{15} hertz). X-rays are primarily used for diagnostic radiography and crystallography.

Computed tomography (CT), originally known as **computed axial tomography** (CAT or **CT scan**) and **body section roentgenography**, is a medical imaging method employing tomography where digital geometry processing is used to generate

a three-dimensional image of the internals of an object from a large series of two-dimensional X-ray images taken around a single axis of rotation.

Positron emission tomography (PET) is a nuclear medicine medical imaging technique which produces a three dimensional image or map of functional processes in the body.

The term **pacemaker** has multiple meanings: In biology and medicine, **Cardiac pacemaker** is a group of cells within the heart that together initiate contractions and set the pace of beating. **Artificial pacemaker** may be implanted to provide proper heart rhythm when the body's natural pacemaker does not function properly.

An **infusion pump** or **perfusor** infuses fluids, medication or nutrients into a patient's circulatory system. It is generally used intravenously, although subcutaneous, arterial and epidural infusions are occasionally used.

A **Heart-Lung Machine** (HLM) is a device that temporarily takes over the function of the heart and lungs. This technique is referred to as Cardiopulmonary Bypass (CPB). Heart-Lung Machines are operated by allied health professionals known as Perfusionists.

Tissue engineering can perhaps be best defined as the use of a combination of cells, engineering materials, and suitable biochemical factors to improve or replace biological functions in an effort to affect the advancement of medicine.

Biomedical Engineering

Biomedical Engineering is the application of engineering principles and techniques to the medical field. It combines the expertise of engineering with

medical needs to improve healthcare. It is a less known discipline than other specialties such as electrical engineering or mechanical engineering. An increasing number of universities with an engineering faculty now have a biomedical engineering program or department from the undergraduate to the doctorate level. Traditionally, biomedical engineering has been an interdisciplinary field to specialize in after completing an undergraduate degree in a more traditional discipline of engineering or science. However, undergraduate programs are becoming more widespread.

Clinical engineering is a branch of biomedical engineering for professionals responsible for the management of medical equipment in a hospital. A **Clinical engineer** is "a professional who supports and advances patient care by applying engineering and managerial skills to healthcare technology." The tasks of a clinical engineer are typically the acquisition and management of medical device inventory, supervising biomedical engineering technicians (BMETs), ensuring that safety and regulatory issues are taken into consideration and serving as a technological consultant for any issues in a hospital where medical devices are concerned. Clinical engineers work closely with the IT department and medical physicists.

Cross-disciplinary activities are the norm, often involving physicians, nurses, medical technologists, information technology professionals. pharmacists, administrators, medical device manufacturer sales and engineering, and local and national regulatory authorities. Clinical engineers generally team with Biomedical

Equipment Technicians (BMETs) to support and maintain the medical devices used at the point of delivery of care.

Biomedical engineers usually require degrees from recognized universities, and sound knowledge of engineering and human anatomy and physiology. Their jobs often pay well (ranging from US $50,000 to $100,000 per year in 2005). Though the number of biomedical engineers is currently low (under 10,000), the number is expected to rise as modern medicine improves. Universities are now improving their biomedical engineering courses because interest in the field is increasing.

Biological engineers are similar to biologists in that they study living organisms. They are engineers because they have a practical goal in mind; they use research to create usable tangible products. In general, biological engineers attempt to 1) mimic biological systems in order to create products or 2) modify and control biological systems so that they can replace chemical and mechanical processes.

Medical Devices

A typical biomedical engineering department does the corrective and preventive maintenance on the medical devices used by the hospital, except for those covered by a warrantee or maintenance agreement with an external company. All newly acquired equipment is also fully tested. That is, every line of software is executed, or

every possible setting is exercised and verified. Most devices are intentionally simplified in some way to make the testing process less expensive, yet accurate. Many biomedical devices need to be sterilized. This creates a unique set of problems, since most sterilization techniques can cause damage to machinery and materials.

Most medical devices are either inherently safe, or have added devices and systems so that they can sense their failure and shut down into an unusable, thus very safe state. A typical, basic requirement is that no single failure should cause the therapy to become unsafe at any point during its life-cycle. Imaging technologies, such as MRIs, X-rays, CT scans, PET scans and PET-CT scans are typically the most complex equipment found in a hospital. Some of the modern devices that followed the invention of X-ray machines include pacemakers, infusion pumps, the heart-lung machine, dialysis machines, diagnostic equipment, artificial organs, implants, and advanced prosthetics.

Discussion

1. What does Biomedical Engineering combine?
2. How was Biomedical Engineering traditionally considered?
3. What is clinical engineering?
4. What is a clinical engineer/
5. What are the tasks of a clinical engineer?
6. Who should the clinical engineer cooperate with?
7. What do Biomedical engineers usually require?
8. Who are universities now improving their Biomedical engineering courses?
9. In what way are biological engineers similar to biologists?
10. What does a typical biomedical engineering department do?

11. How can sterilization be a problem to biomedical devices?
12. Safety is an important factor for medical devices discuss.
13. What are the most complex equipment found in a hospital?
14. What are some of the modern devices that followed the invention of X-ray machines?

Linguistic Drills

William Shakespeare

Most people have heard of Shakespeare and probably know something of the plays that he wrote. However, not everybody knows much about the life of this *remarkable* man, except perhaps that he was born in the market town of Stratford-upon-Avon and that he married a woman called Anne Hathaway. We know nothing of his school life. We do not know, for example, how long it lasted, but we *presume* that he attended the local grammar school, where the principal subject taught was Latin.

Nothing certain is known of what he did between the time he left school and his departure for London. According to a local *legend,* he was beaten and even put in prison for stealing rabbits and *deer* from the *estate* of a neighbouring *landowner,* Sir Thomas Lucy. It is said that because of this he was forced to run away from his native place. A different legend says that he was *apprenticed* to a Stratford *butcher,* but did not like the life and for this reason decided to leave Stratford.

Whatever caused him to leave the town of his *birth,* the world can be *grateful* that he did so. What is certain is that he set his foot on the road to *fame* when he arrived in London. It is said that at first he was without money or friends there, but that he earned a little by taking care of the horses of the gentlemen who attended the plays at the theatre. In time, as he became a *familiar* figure to the actors in the theatre, they stopped and spoke to him. They found his conversation so *brilliant* that finally he was invited to join their company.

Earlier than 1592 there is no *mention* of Shakespeare either as actor or as *playwright*, and the name of the theatre he worked in is not known. However, by this date he had become one of the three leading members of a company of actors called the Lord Chamberlain's men. This company was under the *protection* of the Lord Chamberlain, a powerful nobleman and an official at the Queen's Court. The company travelled about the country, giving *performances* in different towns, and also performed plays at Court.

From what we know of his later life, it is clear than Shakespeare's connection with the theatre made him a wealthy man, since his plays *attracted* large *audiences* and he shared in the profits. Towards the end of the sixteenth *century* he bought a large property in Stratford. It is not certain when he went back there to live, but it was probably around 1603. He is not recorded as having acted in any play after that date, though he continued writing. No less than eleven of his plays were *produced* during the next ten years. These include the great *tragedies* 'Othello', 'Macbeth' and 'King Lear'. His last work was 'The Tempest', but he may have shared in the writing of the *historical* play 'King Henry VIII'.

Even after his *retirement* he *frequently* visited London. Since the road between Stratford and London passed through Oxford, he would rest there at the home of his friend John Davenant, who had a deep respect and *affection* for the playwright.

Shakespeare died in 1616. Some years earlier he chose a *gravestone*, under which he was to be buried. He had a *curse* *engraved* on this stone which *threatened* to bring *misfortune* on anyone who might remove his body from his grave. It seems strange that he should have had this fear. He must have known how greatly he was respected, even in his lifetime, for the *genius* that he showed in his plays and poems. It seems impossible that his *remains* could have been *disturbed* after his death.

1. Choose the word or phrase from the three in brackets which is needed to complete each sentence:

a) Shakespeare was forced to run away from (London, Stratford-upon-Avon, Oxford).

b) According to legend (he was apprenticed to a butcher, he taught Latin in a grammar school, he had a large estate near Stratford).
c) In London (he became Lord Chamberlain, looked after horses, sold the rabbits that he had stolen).

d) He (made a lot of money, made very little money, was left without money or friends) by writing plays.

e) The play 'Henry VIII' (was written entirely by Shakespeare, has no connection with Shakespeare, may have been written in part by Shakespeare).

2. Make one sentence from each pair of sentences, using relative words in place of the words in italics and putting in commas where necessary:

a) Shakespeare used to go into the fields belonging to Sir Thomas Lucy. He killed rabbits and deer *there.*

b) He was apprenticed to a butcher. He did not like *it.*

c) He became a familiar figure to the actors. *They* would stop and speak to him.

d) John Davenant lived in Oxford. *He* was a friend of Shakespeare.

e) Shakespeare wrote brilliant plays. *They* made him famous.

3. Rearrange the words in Column B so that each word is opposite a word in Column A which has a similar meaning:

A	B
remarkable	thankful
presume	well-known
estate	dramatic author
grateful	landed property
familiar	extraordinary
playwright	often
frequently	affection
love	ill-luck
misfortune	suppose

4. Find words in the passage to complete these sentences:

a) When he left school, Shakespeare was ___ to a butcher.

b) The school he attended is thought to have been the ______at Stratford.

c) Shakespeare is said to have stolen rabbits and ___from the___ of Sir Thomas Lucy.

d) Shakespeare achieved both ___and fortune in London.

e) The actors admired him for his brilliant ___.

f) Crowds of people attended the ___ of his plays.

g) His greatest plays were ___ on the stage towards the end of his life.

h) Shakespeare was buried under a ___ that he himself had chosen.

i) On it was ___ a terrible ___.

j) One cannot believe that anyone would wish to disturb Shakespeare's___ after his death.

5. The words in Column B are opposite in meaning to those in Column A, but they are not in their proper order. Re-arrange them to make pairs of opposites:

A	B
public	strange
ancient	similar
different	shallow
comic	infrequent
familiar	dull
deep	modern
successful	tragic
frequent	insignificant
brilliant	private
remarkable	unsuccessful

6. Give one word instead of each of these phrases:

a) act of going away from a place

b) number of people assembled to watch a performance

c) very great talent

d) receive part of

e) state of no longer working

7. Fill the blanks in the following passage with suitable verbs from this list:

are still standing, was built, have been preserved, stretching, used, had fallen, built, know, were also built, was

Bridges

The first bridge that _____by man ___probably a natural bridge. Men no doubt ___ a tree trunk that _____ across a stream. Later, man ___ his own bridges. We ___ that bridge building began very early in history. The Chinese and the Greeks ___bridges thousands of years ago. But the greatest bridge builders of ancient times were the Romans. No wooden bridges built by them _____ ___. But a number of their stone bridges________. Some very fine bridges ________in twelfth century Europe.

The first cast iron bridge _____ in 1799 in England. The most modern type of bridge is the steel bridge.

The Bayonne Bridge, ___from Bayonne, New Jersey, to Staten Island, New York, is one of the largest steel arch bridges. It___ ___in 1931.

8. Find verbs in the passage corresponding to these nouns:

attraction, presumption, production, performance, threat

9. Answer these questions:

a) Why did the actors at the theatre invite Shakespeare to join their company?
b) Who was threatened with misfortune, according to the curse on Shakespeare's gravestone?
c) What else did Shakespeare write beside plays?
d) What were grammar school pupils taught in Shakespeare's time?
e) Why did Shakespeare look after gentlemen's horses when he first arrived in London?

10. Fill each blank with the necessary preposition from this list:

about, at, between, by, for, from, in, of, on, through, to, with

a) They gave performances __ different towns.

b) Shakespeare stayed   his friend's home   Oxford___ his way ___ Stratford ___ London.

c) The road ___ Stratford and London passed ___. Oxford.

d) Shakespeare's connection ___ the theatre brought him fame.

e) He made his fortune ___ writing ___ the theatre.

Part II

Grammar & Language Drills

REPORTED SPEECH (1)

Look at the following sentences.

	'It's only a model'.
The Time Traveller said	'You will notice it looks a bit odd'.
	'It took two years to make'.

These were the Time Traveller's *actual words*. The author might have expressed them in reported speech, like this:

		it was only a model.
The Time Traveller	said that told us that	we would notice it looked a bit odd.
		it had taken two years to make.

Note the following points.

A. The changes of tense when the verb in the reporting clause is in the past (e.g. 'he said that ....').

1. The present tense in direct speech becomes the past tense in reported speech.
2. 'Will' and 'shall' in direct speech usually become 'would' and 'should' in reported speech.
3. The past tense and present perfect tense in direct speech become the past perfect in reported speech.
4. The past perfect tense in direct speech does not change in reported speech.

Main tense changes in reported speech.

	past perfect	**past**	**present**	**future**
Direct speech	he had gone	he has gone he went	he is going he goes	he will go

BECOMES

Reported speech ("he said that ...")	he had gone	he was going he went	he would go

B. to say that....

BUT to tell *someone* that ....

C. '*You* will notice' becomes 'that *we* would notice'.

D. Requests and commands can also be expressed directly by 'say'. But they are reported as:

The Time Traveller said	'Have a good look at the thing'. ' Look at the table'.

The Time Traveller	asked us to	have a good look at the thing.
	told us to	look at the table.

You do not have to worry about tense changes here. In reported requests and commands, the verbs *tell, ask, order,* take 'to' + the infinitive.

Exercise 1

Turn the following sentences into reported speech. Begin each sentence with either 'he told us that' or 'he asked us to'.

1. 'It is my plan for a machine to travel through time.'

2. 'I want you to understand that if you press this lever here, the machine will go into the future.'

3. 'I am going to press the first lever, and off the machine will go.'

4. 'I don't want to waste this model and then be told I'm a fake.'

5. ' Lend me your hand.'

Exercise 2

In the following exercise, turn the reported speech into direct speech. Write only the name of the speaker, followed by his actual words. Start like this: Manager. Come in. Please sit down. . . .

The manager opened the door of his office and told me to come in. He asked me to sit down, and offered me a cigarette. He said that he was sorry that I had found the meal at his restaurant so revolting, and that he was sure that if I came again I would find the food more satisfactory. He continued that he had investigated my complaint, and had discovered that, on the evening I had come, they had just taken on a new chef. This, he said, probably explained the bad quality of the meal. He finished by asking me to visit the restaurant again, any time I wanted to, without charge.

REPORTED SPEECH (2)

Revise the section on reported speech (1) which dealt with reported statements and reported commands.

Questions also appear in reported speech:

'How would you feel if one of your family died in an accident?'

'Do you deny this?'

'Can we ever prevent all accidents?'

In reported speech these questions become:

The Superintendent asked Mr. Deverill how he would feel if one of his family had died in an accident.

Mr. Deverill asked the Superintendent	if he denied it. if they could ever prevent all accidents.

Note the following points:

A. A direct question beginning with a 'question word' (what? where? why? how? etc.) retains that question word in reported speech.

B. A direct question which is formed purely by inverting the verb ('Is he French?') requires the additional word 'if (or 'whether') in reported speech ('He asked him if he was French').

C. The verb is *not* inverted in reported questions.

D. The tenses change according to the rules shown in Unit 1.

Further examples

Direct speech: The man asked 'where are you going?'

Reported speech:	The man asked me where I was going.
D.S.	'Will you come with me?'
R.S.	He asked me if I would come with him.
D.S.	'How long have you been waiting?' she asked.
R.S.	She asked him how long he had been waiting.

Exercise

Read the following dialogue, then rewrite it in reported speech.

Salesman: Good morning, madam. What can I do for you?

Customer: Well, I'd like to buy a car.

Salesman: Well, I think I can help you. What kind of car do you have in mind? New or second hand?

Customer: A second hand one, I think - nothing too expensive. And I prefer a small car to a large one.

Salesman: I think we have just the car for you, madam - that red one. It's only two years old, and it's only £2000.

Customer: £ 2000! I can't afford that! I only have £200 to spend.

Salesman: Oh dear, madam. I'm afraid I can't help you, then. We've got nothing cheaper than £900.

Customer: In that case I shall try another garage. Thank you for your attention. Goodbye!

PAST/PRESENT PERFECT TENSES

Look at these sentences.

'No other invention has surpassed its usefulness.'

That year Bell exhibited his telephone at the Centennial Exposition at Philadelphia.

Most sentences which use the past tense have a time adverb which shows that the action is finished.

Examples:

He wrote a letter *yesterday*. He caught the train at *10.00*.

The present perfect tense is used when it is not important to know when the action took place or when it started taking place. What is important is that the effect of the action matters now.

Example:

A: (teacher to pupil) Do you know that poem?)

B: (pupil) Yes, I've learnt it. (He learnt it some time before and he knows it now.)

Adverbs which are often used with the present perfect tense are 'already', 'since', 'for', and 'just'.

Examples:

He's already cooked the meal. He's been in the country since January.

He's just closed the door. He's worked there for three months.

Exercise

The present perfect can *be* used with 'since' and 'for'. Remember you use 'since' with a date, a definite day or time (1^{st} July, New

Year's Day, 12 o'clock etc.) and 'for' with an amount of time (three months, one year, two hours etc.)

Now put the verbs in these sentences into the correct tense and add 'since' or 'for'

1. 'You (be) here .... long?' 'No, I only (work) here .... last week.'
2. They (go) to the same place every year. . . . 1965 for their holidays.
3. 'I (not hear) from John .... last month.' 'Oh, he (telephone) me yesterday.'
4. I (see) my father in hospital yesterday. He (be) there .... two months.
5. They (start) to build that new post office three years ago. They (not work) on it.... December, because of the weather.
6. My neighbour (play) his violin every night.... a week. Thank goodness he (stop) last night!
7. I (work) hard .... 9 o'clock this morning and my secretary just (bring) me a cup of coffee now.
8. I (see) the photo of the escaped prisoner in the newspaper this morning. He (be) out of prison .... last Tuesday.

ADVERBS OF DEGREE: HARDLY

In the two passages *hardly* has been used in four different ways and each time it has a slightly different meaning.

A. 'He could *hardly* breathe.'

In this sentence, 'hardly' is used with 'could' (or 'can') and means 'only with difficulty'.

B 'He could *hardly* have done anything else in the circumstances.'

'hardly' is again used with 'could'.

Here *hardly* can be expressed in another way: It would have been impossible for him to have done anything else. *Hardly* can be used with 'any' and 'ever' as in the following sentences:

C There was *hardly any* time to spare.'

When 'hardly' is used with 'any', it means 'very little.'

D 'He hated the telephone and *hardly ever* used it.'

When 'hardly' is used with 'ever', it means Very, very seldom'.

Exercise 1

Now imagine that you are complaining to your local telephone company about the telephone kiosk in your street. Describe what you would say using *hardly* in as many different ways as possible. Use the following sentences to help you.

Start by saying: 'I hardly ever use the telephone kiosk because ....

1. The nearest kiosk is a long way away.
2. You have to have the correct money whenever you want to use it.

3. The telephone is often out of order.

4. There are usually queues of people waiting to use it.

5. There are often no telephone directories.

CONFUSING WORDS: SOME TIME/ SOMETIMES

Look at these examples.

A 'Experiments on a telephone/television have been under way for some time.

B 'Although telegrams had been in use for some time and the equipment was in some ways similar, ... it was not sophisticated enough to pick up speech.

The words 'some time' can be substituted in examples A and B for 'quite a long time'.

'Some time' can also be used when any particular time during a period of time is expressed, as in example C.

C Can I see you some time (any time) this afternoon (a period of time)? However, in example D, 'sometimes' means 'occasionally'.

D This picturephone should be useful for business situations but possibly embarrassing for social occasions sometimes.'

Exercise 2

Now complete the sentences in this telephone dialogue, using 'some time' or 'sometimes'.

A: Greenford Garage.

B: May I speak to Mr. Greenford please?

A: Oh, I'm afraid he went out.... ago.

B: I see, do you know what time he'll be back?

A: No, ... it takes .... and .... he gets back quickly.

B: Well, my car hasn't been serviced for.... and I wonder if it could be done .... soon.

A: Of course, Madame, when would you like us to do it?

B: . . . . Mr. Greenford does it for me in my lunch hour. Is that possible?

A: Well, could you bring it in .... around lunch time on Wednesday?

B: Oh thank you. My name's Mrs. Blackburn. Goodbye.

A: Goodbye.

THE PASSIVE VOICE

Look at the following sentences.

- Trains were considered to be dangerous.

In this sentence, *trains* are what we are interested in. It is unnecessary and therefore unimportant to say *who* was doing the considering, and so we do not say,

- People considered trains to be dangerous'.

Decide what is the most important thing in the following sentences.

- 'I have never been so laughed at in my life.'

- The hovercraft and the flying saucer will probably be considered as a necessity to everyday life.'

- 'How much further can transport be developed?'

Exercise 1

Change the verbs in Roger's speech below into the passive voice.

Tom Jones wanted to buy a second-hand car. He went to see Roger French who was selling his. While Roger was showing him the car he said,

'Ford made this type of car in 1950. I have done a lot of work on it and I've overhauled it every year. Someone put a new engine in it four years ago. Oh, by the way, I'm mending the handle of that door now. I was going to repaint the roof when someone hit the car, so I resprayed the whole car three months ago. I drive it everyday so you can see I use it regularly. I've replaced all the old tyres with new ones and I've just bought a spare one. If someone treats it with care it'll be in good condition for some years.

Would you like to try it?'

Exercise 2

Sometimes we use 'by' when it is necessary to know more information. e.g.:

- 'On the other hand communication was certainly helped by the railways.'

Change these sentences into the passive voice using 'by'.

1. The new government has made a lot of traffic laws this year.
2. The customs officers questioned the tourist about his camera.
3. Bad weather will affect the hovercraft's timetable this evening.
4. A policeman is asking the suspicious-looking man to leave the train.
5. The ship's owners are going to make my uncle a captain.
6. They usually allow my grandfather to sit in the guard's van in a train, because he's in a wheelchair.
7. The director of the company is interviewing all applicants for the post.
8. The teachers of the school are going to put on a play.
9. Heavy falls of snow have covered roads all over the country.
10. Harold Pinter wrote The Caretaker'.
11. Scotland Yard is investigating a case involving the smuggling of drugs.
12. Parliament must agree to a bill before it can become a law.
13. Alexander Bell invented the telephone.
14. The washing machine has ruined her silk dress.
15. Everyone who lives, works or studies in the area can use the local public library.

16. The first version of the fountain pen ____________ (make) thousands of years ago.

17. The quill pen ________________ (not use) for over a hundred years.

3. Your suggestion ________________________ (consider) next week.

4. Do you think the problem _______________ (can solve) in the future?

5. Many new ideas _______________________ (develop) at the moment.

6. The ballpoint pen ______________________ (invent) by Laszlo Biro.

Should / ought to

When you wish to *advise* someone to do something, you must use *'should'* (negative = shouldn't) or 'ought to' (negative = 'oughtn't to'),

When you give advice, you are aware that the person to whom you give it may not do what you advise. In this way, 'should' and 'ought to' are not as 'strong' as 'must'.

Look at these two sentences:

A. You must go to the doctor (it is *necessary* for you to go)

B.	you	should ought to	go to the doctor (I advise you to, it would be best for you)

Now look at these sentences from the passage:

C.	There	should ought to	by very high penalties.
D.	We	should ought to	tighten the law.
E.	They	should not oughtn't to	be allowed to drive at all.
F.	People	shouldn't oughtn't to	drink at all if they are drunk.

Note that 'should' and 'ought to' can have a present as well as a future meaning. In sentence F above, they have present meaning:

- People shouldn't drink at all if they are drunk (but they probably do).

Exercise 1

Below you will see some situations. Write a sentence, using 'should' or 'ought to' (or the negatives), which would be suitable in the circumstances.

Example: You are a passenger in a car, and the driver is going too fast.

Answer: 'You shouldn't drive so fast.

1. A friend of yours is very greedy, and is getting very fat.
2. **You have seen a very good film, which you think your friend would**
3. One of your relations has got a nasty cough, and smokes 40 cigarettes a day.
4. You have got an exam in two weeks time, but you don't do any work because you are too interested in playing football/tennis. You think you will fail the exam.
5. A friend of yours is recovering from 'flu, and has been invited to a party tonight.

VERB CONFUSIONS

Look at these examples.

'before lighting their cigars and pipes.

'he turns off the light'

'and puts out his last cigarette'

Verbs associated with 'lights', 'fires', 'cigarettes' and so on can be confusing.

You *light*	a pipe. a cigarette. a fire	(that is, something that is *intended* for burning)

You *set fire to*	a building. a waste-paper basket. (something which is *not* intended for burning)

You *turn on**	an electric light a television

You *put out**	a cigarette. a fire.

You *put off**	a television a light

*Note that the preposition can come after the object in these examples (e.g. You turn a television on).

PHRASAL VERBS

Look at these two sentences

'the generation .... that first took up smoking as a mass habit...'

'Let's give up smoking.'

You *take up* (= start) something that you do *regularly.*

When you stop a regular activity, you *give it up.*

Notice the construction of the following examples.

- I've given up learning English; it was much too difficult.
- John has taken up golf; he says it makes him much healthier.
- You'll get fat if you eat so many potatoes. Why don't you give them up.
- My cousin started doing yoga last year. I think I might take it up as well.

EXPRESSIONS OF TIME

Look at this sentence.

'Do you spend the first ten minutes of every morning coughing?'

To spend time doing something' is one of several expressions using the word 'time'.

Here are some others:

I waste time	I've got time ....
I kill time ...	I'll make time ....

Exercise

In the following 5 sentences you will see that the verb is missing. Fill in the blanks, using in each case the appropriate verb (in the right tense) from the above expressions.

1. I (not) .... time to see her today. She'll have to come back tomorrow.
2. I had two hours before the film started with nothing to do, so I .... time by looking in shop windows.
3. When I was in Paris last year I .... a lot of time sight-seeing.
4. Although the manager was having an extremely busy day, he .... ; time to listen to the complaints of a dissatisfied customer.
5. 'You said you'd be here at 3 o'clock, and now it's nearly 5. I .... two hours waiting for you.'

THE FIRST CONDITIONAL

Look at the following sentences.

- 'If you're careful, you won't kill yourself.'
- 'If you put it in your mouth, I'll light it for you.'
- 'If you suck carefully, you'll find it's quite pleasant.'
- 'If you come round later in the week, we'll go out and have a meal.'

Be particularly careful about the tenses in the first conditional. Remember, we use this structure to express what we *will* do *if* something *happens*.

Exercise 1

Complete the following sentences.

1. 'If you don't give up smoking ....'
2. 'If you are going to the shops, ... me a packet of cigarettes?'
3. 'I think cigarettes are awful. I .... if I ever become Prime Minister!'
4. 'I shall forbid my children to smoke, if. . . .'
5. 'If you .... for some cigarettes, I'll pay you back tomorrow.'

THE SECOND CONDITIONAL

Look at this sentence.

- 'If Amsterdam were to become London's third airport, then British airports and airlines would lose a lot of money.'

- Throughout this interview, Miss Mulder and Mr. Millard are talking about what *would happen* if the third airport *were* to be in Amsterdam.

Find other examples of what would/could happen if this were the case.

Exercise 2

Now complete the following sentences using this conditional construction. Notice that we needn't use a comma unless the 'if clause precedes the main clause.

1. If there were no aeroplanes, ...
2. How would you get home .... ?
3. If only I knew, ...
4. What .... if you were me?
5. I wouldn't fly even if ....
6. .... unless she were very angry.
7. Supposing I lent you the money, ...
8. She would marry him provided that ....
9. .... if you paid me!
10. There wouldn't be any point in taking a picnic if ....
11. She wouldn't go to the doctor unless ....
12. If he lost his job, ...
13. .... provided that you did as I said.
14. If I couldn't speak English, ...

THE THIRD CONDITIONAL

Consider these sentences from.

- 'If he *had stumbled*, he *could* so easily *have fallen* over.'

- 'If he *had tottered*, the weight of the pack *could have twisted* him around or *made* him fall.'

- What could/would/might have happened if Armstrong had fallen on the moon?

N. B. He didn't fall, so we are considering the impossible.

Exercise 3

Complete the following sentences using this conditional construction.

1. If the Apollo 11 programme hadn't been very carefully planned, ...
2. We couldn't have seen what was happening on the moon if....
3. If I had been the first astronaut to step on the moon, ...
4. Armstrong and Aldrin couldn't have walked on the moon unless ....
5. If. . . ., he might have torn his space suit.
6. If gravity on the moon had been the same as on earth, ...

Now answer these questions.

- What would life have been like if the telephone hadn't been invented?

- How would communications have been different if men like the Wright brothers hadn't invented the flying machine?

- How would life have been different if tobacco had never been brought to England?

- Would the world have been a better place without the motor car?

- If it hadn't been for Trevithick's steam engine, how would we travel today?

In the last question, 'would travel' is used instead of 'would have travelled'. This is a common alternative when we are talking of something that is still true in the present. ,

Do you think man would have walked on the moon in 1969 if it hadn't been for Galileo Galilei? ....

ADVERBS: 'BARELY'

Look at these two examples.

- 'I could *barely* believe my eyes . . . .'

- 'I tried lifting the bulky weights but could *barely* manage it.'

In both these sentences the word *barely* means 'only just'.

Exercise 1

Write a short dialogue between two people who are trying to escape from a prison, at night, by climbing a wall. Whenever it is possible use the word *barely.*

WORD ORDER WITH PREPOSITIONS 'TO' AND 'FOR'

Look at the order of the words in this phrase. '. .

. . and (I) gave the coins *to* someone.'

It is possible to leave out the word *to* by changing the order of the words:

'. . . . and (I) gave someone the coins'.

This can be done with other verbs such as 'take', 'bring', 'send', 'lead', 'pass', 'show', 'throw' etc.

It is also possible to change sentences in the same way using the word *for* with verbs such as 'get', 'keep', 'reserve', 'build', 'make', 'order', 'fetch'.

The librarian found a book *for* me.' OR The librarian found me a book.'

Exercise 2

Write two short passages explaining what has to be done at a wedding, one passage using *to* and *for* and the other without them.

A USE OF THE INFINITIVE

The infinitive can follow words such as 'the best', 'the first', 'the last' etc.

- 'For we were *the first* to find an amount of fused clusters of coins that was so large'

Exercise 3

Write six sentences containing this structure about discoveries or inventions.

Example: 'Cortez was *the first* European to get to Mexico'.

'SUCH A'/'SO'

- 'For we were the first to find an amount of fused clusters of coins that was 50 large.'

This could be changed by substituting the word 'so' with 'such a'.

- 'For we were the first to find *such a* large amount of fused clusters of coins.'

Such a is followed by an adjective + a noun, and so is followed by an adjective only.

Example:

'Florence is *such a* beautiful city.' or 'Florence is *so* beautiful.'

The city of Florence is *so* beautiful.'

Exercise 4

Now write a description of a place that you have visited that made an impression on you, using so and such a.

Note the following points.

A *When* can be used to join two action's that happen at the same time.

'*When* I shouted to the boat to come quickly I could see that they were having trouble with the anchor.'

B It can also be used to show that the second action follows the first.

'*When* the boat stopped directly above me, I scooped up a handful of coins, ..."

C *When* can be replaced by as when the two actions happen at the same time.

'*As* the lights changed, the cars moved forward.'

D *When* cannot be used when the second action happens before the first is finished. In this case as must be used.

'*As* he jumped off the boat he realised he had left his oxygen tank behind.

Exercise 5

Now write what you would say to a shop security officer who has caught you taking an object from the shop without paying for it. You are explaining to him that it was forgetfulness that made you do it. Use the conjunctions ***when*** and *as* in your explanation.

CONNECTIVES

There are words which connect ideas, whatever their position in a sentence may be. It is possible to express two ideas in different ways, as in sentences A- D.

A It would appear that most ancient cultures have been investigated and opened up. *Nevertheless,* this is not the case ....

B *Although* it would appear that most ancient cultures have been investigated and opened up, this is not the case ....

C It would appear that most ancient cultures have been investigated and | opened up *but* this is not the case ....

D It would appear that most ancient cultures have been investigated and opened up.

However, this is not the case ....

These four connective words are used when the two ideas appear to be in contrast to each other.

Although can be used in two different positions in a sentence.

Examples:

- *Although* doctors have discovered that smoking is bad for people's health, some people continue to smoke.
- Some people continue to smoke *although* doctors have discovered it is bad for people's health.

Exercise 1

Now join these ideas in the four different ways.

1. People always said that the world was flat. Magellan proved that he could sail around it.

2. People used to say that Troy was a mythical city. Schielmann found it had existed.

3. People never thought it would be possible to go to the moon. The Americans have got there.

4. Many people didn't want railway lines built across the countryside. They were built.

Other Words that Connect Ideas:

Words such as *in order, so that, so* and *because* can be used to connect ideas when one idea is an expected result of the other.

Examples:

- He worked hard. He wanted to pass the exam.
- He worked hard *in order* to pass the exam.
- He worked hard *so that* he could pass the exam.
- He worked hard *so* he could pass the exam.
- He worked hard *because* he wanted to pass the exam.

Exercise 2

Join these sentences in the same way, using in order, so that, so or because.

1. He made rousing speeches. He wanted to get the support of the people.
2. He went to evening classes. He wanted to become an engineer.
3. She sunbathed everyday. She wanted to get a tan.
4. He did two jobs a day. He wanted to provide for his family.
5. The group did exercises every morning. They wanted to be fit.

Exercise 3

This is a supposed diary entry made in 1845 by Layard, the archeologist who excavated Nimrud in Assyria-now Iraq. Join the sentences so that they read as a less disjointed piece of writing.

November 15th, 1845.

I spent a sleepless night. I had a lot of worries. I got up early. I wanted to start work as soon as possible. I was worried about the Pasha's reaction to my work on Nimrud. He is in charge of this district. I went ahead with the digging, which started at dawn. I have hired seven men to work on the site. I would have liked to have got more. I hope they will keep the matter a secret. I have only got a short time to do this work. The country is in revolt against the Turkish government. Can I do it in a month? Evans took twenty five years to find what he wanted. I am very worried about the political situation of the country. The work seems to be going well so far. I don't think the diggers understand what I am trying to do. I hope to find a royal palace. I have only seen alabaster walls so far. I must get the men to dig faster. I want to show the Pasha that I am only interested in archeology and not in gold.

RELATIVE CLAUSES: SUBJECT PRONOUNS

Look at the following sentences.

- 'All possible routes were taken by the "Forty-Miners" *who set out to find gold.'*

- This was the magnet *that attracted these first settlers.*

Here the 'Forty-Miners' and 'the magnet' are explained by the words in *italics* that follow them. Notice that the relative clause immediately follows the word it explains, which is not necessarily at the end of the sentence. 'Who' and 'that' are the *subjects* of the relative clause in both cases.

Exercise1

Join the following pairs of sentences so that the word in italics is explained. Example:

- Men had previously been thought sensible and industrious. These left their jobs.

- Which men?

- Men who had previously been thought sensible and industrious left their jobs.

1. James Marshall was the *man*. He discovered gold in California.
2. *Men* could lose fortunes gambling. They had found gold.
3. The *mining-villages* were ramshackle. They were built by the 'Forty-Miners'.
4. *Miners* risked being robbed. They had gold-dust.
5. The *people* often had nothing to lose. They arrived first.

6. San Francisco was a small *village*. It was invaded by prospectors from all over the world.

7. *People* crossed at the Isthmus of Panama. They had money.

RELATIVE CLAUSES: OBJECT PRONOUNS

Look at these sentences.

- The car *the man was driving* was stolen.

- The Police caught *the man they were looking for.*

Again 'the car' and 'the man' are explained by the words in *italics*. But notice that here 'the gold' and 'the man' are the objects of the relative clauses, and the relative pronoun is usually omitted.

Exercise 2

Find an example of this type in the passage, and then join the following pairs of sentences without using a relative pronoun.

Example:

- This is a ship. Prospectors sailed in it.

- What kind of ship is it?

- This is a ship prospectors sailed in.

1. The Oregon Trail was one of the *routes*. The 'Forty-Miners' took it.

2. Jesse James was a *man*. Everybody feared him.

3. Red Dog was one of the *villages*. The 'Forty-Miners' lived in it.

4. Lopez was a *man*. The bandits robbed him.

5. Do you know the names of the *companies?* The 'Forty-Miners' set them up.

6. The *story* of the Gold Rush was interesting. I read it.

DEFINITION WORDS

A A farmer is a man who cultivates the land and/or raises animals.

What is a farmer, a clerk, a minister, a banker, a baker, a barber, a bus-conductor, etc.?

Ask each other similar questions about people and their occupations using your own examples. Make your definitions as precise as possible.

B A newspaper office is a place where papers are prepared for publication.

Describe places in the same way, taking examples from both passages, and following up with other examples, such as a market, a prison, a zoo, a laundrette, a theatre, a newsagent's shop etc.

C A Turk is a man who comes from Turkey.

What about other nationalities?

CONFUSING WORDS

A 'ROB' AND 'STEAL'

- They would rob their friends of gold.'

This could be expressed in another way.

- They would steal gold from their friends'.

Exercise 1

Write a description of a recent robbery in your area, substituting 'rob' for 'steal' and vice versa. Remember, you rob someone or somewhere, but you steal something.

'rise' is an irregular verb and it cannot have an object.

'raise' is a regular verb, it can have an object, and can therefore be used in the passive.

Exercise 2

Now write answers to these questions using 'raise' or 'rise'.

- What do you do when you want to speak at a meeting?
- If you were a farmer in Australia, what would you do?
- What happened to the population of San Francisco in 1849?
- What does the sun do every day?
- Why is the cost of living higher now than it was ten years ago?
- What have transport companies done in order to pay their workers more?

PHRASES INTRODUCED BY PREPOSITION + GERUND

Look at these sentences.

- *'After running* the motor a few minutes to heat it up, I released the wire ...'

could be rewritten:

- *'After I had run* the motor a few minutes to heat it up, I released the wire ...'

- *'Before flying* a plane with an engine, the brothers practised with a glider.'

could be rewritten:

- *'Before they flew a* plane with an engine, the brothers practised with a glider.'

Similarly:

On hearing As soon as he heard	the news, Bishop Wright was overjoyed.

The brothers got the news to their father quickly	by sending because they sent
a telegram.	

Wilbur ran with the plane	without letting it go and didn't let it go	until it lifted from the track.

Exercise 1

Rewrite the following paragraph, use the appropriate preposition and gerund instead of the words in italics.

Mr. Crooks sat nervously in the departure lounge, waiting for his flight to be called. *As soon as he heard the* announcement, he jumped to his feet, picked up the large suit-case beside him, and made for the doorway. *Before he found* refuge in the aircraft, however, he was accosted by a burly policeman who ordered him to open his case. *After he had lifted* the lid *and gazed at* the tidy piles of banknotes, the policeman looked at Mr Crooks *but didn't say* anything. Mr Crooks admitted his guilt *because he tried* to escape, but the policeman was ready for him.

Exercise 2

Now rewrite the following paragraph. Use a subject and verb in place of the words in italics. Notice that the subject must be the same in both parts of the sentence.

For example, we could not say:

'After fastening her seat belt, the plane took off'. This would mean that the *plane* had fastened the passenger's seat belt!

Before releasing the wire that held the plane to the track, Orville ran the motor a few minutes to heat it up. *By running at* the side of the machine and *holding* the wing, Wilbur balanced the plane on the track. *On seeing* the plane leave the ground, one of the men took a picture. *After landing,* Orville Wright was very happy. He had flown the machine *without relying* on the wind for power.

NEGATIVE PREFIXES

Exercise 3

- The telegraph operator *misread* Orville's hasty scrawl.'... partly due to the irregularities of the air...'

The word at the end of each of the following sentences can be used in a form that fits in the blank space, when 'ir' or 'mis' is used to make it negative. Be careful to choose the correct prefix!

1. I'm afraid the damage to the car is .... REPAIR

2. I've never seen the word 'canera' before; it must be a .... PRINT

3. Politicians have always been .... TRUST

4. He fell in love with her at first sight; her beauty was... RESIST

5. The man lost his way because he .... the directions. UNDERSTAND

6. Many older people think that the younger generation is completely .... RESPONSIBLE

'OVER-' AND 'UNDER-'

'over-' as in 'overpopulated' means 'excessively'

'under-' as in 'undernourished' means 'insufficiently'.

Exercise

The word at the end of each of the following sentences can be used to form a word that fits in the blank space, when 'over-' or 'under-' is used as a prefix. Be careful to choose the correct one.

1. My steak hasn't been cooked long enough; it's .... DO
2. He left his job because he thought he was .... PAY

3. The student was late because he ....
SLEEP

4. You will put on weight if you keep on .... EAT

5. This photo is very dark; it must have been ....
EXPOSE

6.The man died from an .... of sleeping pills. DOSE

TO BE USED TO/TO GET USED TO'

Look at the following sentences.

- The British have got used to catching a plane from London to any destination in the world.'

- 'We are used to handling flights to and from most destinations in the world.'

- If you *are used to* living in a town, then you *are accustomed to* it and, perhaps, if you have to move to a town, you will *get used to* it.

Exercise 1

Now answer the following questions using the correct form of 'used to'. Notice that it is always followed by a noun or gerund.

1. Why does travelling abroad sometimes present problems?
2. Supposing you had to live abroad for a long time, what would you have to do?
3. A rich man has lost all his money. What must he do now?
4. A poor man won £50,000 on the pools. What did he feel at first when he had so much money?
5. The role of women in society is changing rapidly. How are men reacting to this?

'NOT ONLY .... BUT ALSO'

Look at the following sentences.

- 'Not only does this cause problems of passenger comfort, but also, in the long term, it must bring up the question of safety.'

-

This is an emphatic way of saying:

- This causes problems of comfort

  and also, in the long term, must bring up the question of safety,

  and, in the long term, brings up question of safety as well.

- '*Not only* do I like flying, *but* I *also* like travelling by train.'

Could be expressed in the following ways:

- 'I not only like flying, but I also like travelling by train.'
- 'I like flying and I like travelling by train too'

  as well.'

Notice that the subject and verb are inverted after 'not only' when it precedes the subject.

Exercise 2

Now rewrite the following sentences. Use the 'not only' construction as in the examples.

1. He had a house in London, and a house in Paris as well.
2. He was a famous singer, and so was his wife.
3. She not only could act, but she could also sing.
4. She was a star of the stage, and of the screen too.
5. He married twice, and so did she!

CONFUSING WORDS

The words 'like' and 'as' are both used for making comparisons, but there is sometimes confusion as to which to use.

'LIKE'

Example: '. . . . the powder like velvet underfoot. . . .'

Now find other examples of this kind. What do you notice about the words following 'like' in each case?

'like' is followed by a noun or gerund

Example: 'It was like walking on velvet.'

'AS'

Example: There seems to be no difficulty in moving around as we suspected.

Note the following points

A 'as' is followed by a verb

B In comparative use, a double 'as' is used

Example: 'He worked as hard as he could.'

C Don't be misled by cases where the verb is omitted

Examples: 'He worked as hard as (was) possible.'

'Her lips were as red as cherries (are).'

D 'as' may be followed by a noun

Example: 'He worked hard as a student.'.

'as' is not being used in a comparative sense here, and the sentence could be rewritten: 'He worked hard when he was a student'.

Exercise 1

Now fill in the blanks in the following paragraph, using 'like' or 'as' where appropriate.

While working for his finals, Tom smoked .... a chimney, and .... one would expect, he developed a nasty cough and slept very

badly. But he worked .... a demon for the first time in his life (. . . . many other students) and passed his exams with flying colours. When he heard the good news, he danced round in delight.... would a happy child, and decided to give up smoking. .... soon .... he did so, his cough disappeared and he slept.... a log. Now he has the occasional cigarette, but he never smokes .... much .... he did .... a student, and he feels .... fit. ... a fiddle!

WAYS OF EXPRESSING MOVEMENT

The following verbs appear in *'Moon Walk'*

step	trot	totter	leap
lope	stumble	run	

Exercise 2

After making sure that you understand the meaning of these words, fill in the blanks in the following exercise using each word only once.

1. Look before you .....
2. The leading horse suddenly .... at the last fence, and fell to the ground.
3. The old lady was so frightened that she wouldn't.... out of the house alone.
4. Don't try to .... before you can walk.
5. The drunken man .... out of the pub, clutching his bottle of whisky.
6. The horse broke into an even ....
7. The big dog .... through the wood, as if moving in slow motion.

DEDUCTIONS ABOUT THE PRESENT: 'MUST' AND 'CANT'

Look at the following sentence.

- 'But the moon can't be like the earth, with mountains and valleys.' Tm telling you it must be.'

- Sagredo had been firmly convinced that the moon was completely different from the earth; Galileo however, had evidence which suggested the contrary.

'must' and 'can't' + the infinitive without 'to' are used to express deductions about the present.

Find other similar examples. Then answer the following questions, using this structure to express your deductions.

1. What sort of men do you think Neil Armstrong and 'Buzz' Aldrin are?
2. What must it be like to travel through space and to land on the moon?
3. What do you imagine astronauts have to do during their journeys through space?

DEDUCTIONS ABOUT THE PAST: 'MUST' AND 'CANT'

Look at these sentences.

- 'Well, the astronomers must have been wrong.'
- 'He can't have been right!'

- Galileo concludes from his evidence that astronomers had previously been wrong; Sagredo doubts that a man who had been burnt to death did not in fact deserve such a fate.

When making a deduction in the present about the past, we use 'can't' + the perfect infinitive without 'to'.

N.B. 'couldn't' may replace 'can't' in this case, and *must* be used when the deduction is made in the past, as in this sentence:

- Galileo knew that the astronomers couldn't have seen what the surface of the moon was like without a telescope.

Now answer these questions.

1. What kind of a man was Galileo Galilei?
2. What do you think Armstrong and Aldrin felt when they landed on the moon?
3. What did the astronauts' families feel about the space flight?

DEDUCTIONS SUPPORTED BY CONDITIONAL STATEMENTS

Exercise

What can you deduce from the following sentences? Explain your answers with a sentence using the appropriate conditional pattern.

Examples:

- The policeman arrested a young man.

- The policeman *must have been* suspicious. If he *hadn't been* suspicious, he *wouldn't have arrested* the young man.

- John says he's short of money, but he's got a Rolls Royce.

- He *can't be* short of money. If he *were* short of money, he *wouldn't have* a Rolls Royce.

1. Tom and his wife are always quarrelling.
2. The audience laughed throughout the play.
3. Although Peter is very intelligent, he failed the exam.
4. Some people go swimming in the sea in the middle of winter.
5. Peter came back from Austria with a broken leg.
6. The child was shivering, despite the hot weather.
7. The patient was at death's door, but the surgeon saved his life.
8. When the customs officer saw the man's face, he asked him to open his case.
9. No one answered the door, but voices could be heard inside the house.
10. The student jumped when the teacher asked him a question, and mumbled something inaudible.
11. The woman woke up shouting that there was an elephant in the room.
12. All the food in the refrigerator has gone off.
13. John came to school with a black eye this morning.
14. Although the man accused of stealing protested his innocence, he was identified by two separate witnesses.

'TRY' + GERUND/INFINITIVE

Compare these sentences

- *'Try walking* more and take exercise at the same time.'
- *'Try to use* as few electrical devices as possible.'

We *try doing* something new or for a change, or we *try doing* something as an experiment. So we *try walking* more. . . .

When we *try to do* something, we try and make an effort to do it. We *try to succeed* (not we try succeeding). So *we try to use*. . . .

Example:

Tom arrived home late, and wanted to get in without waking everybody up by ringing the bell. So he was trying *to open* the door. First he tried *turning* the handle, but that was no good. Then he tried *kicking* the door, but nothing happened. He tried *shouting* at it - still nothing happened. Just as he was about the give up, he had a brainwave. He tried *putting* his key in the lock and *turning* it. The door opened!

Now find other examples of your own and explain why the gerund or infinitive is used.

What do you *try doing* if you are
- trying to lose weight?
- trying to get to sleep?
- trying to find somewhere to live?
- trying to find a job?
- trying to give up smoking?
- trying to save money?

'STOP' + GERUND/INFINITIVE

Compare these sentences.

- 'Discover ways to ***stop using*** cars.'

- '***Stop to listen*** to the noises around you.'

'stop' is usually followed by the gerund. When it is followed by an infinitive, as in the second example, it means 'stop and do something.'

- WHAT must you stop ***doing to listen*** to the noises around you?

Exercise

Explain what he/she stopped in each of the following situations, and why. **Example:**

- Nick was working very hard. He went for a walk to clear his head.

- ***What*** did he stop?

- He stopped *working.*

- ***Why*** did he stop?

- He stopped ***to go*** for a walk.

1. Sally and Tom were driving to Scotland. On the way, they had a meal.
2. The professor was giving a lecture. At one point, he drank a glass of water.
3. The secretary was typing. Then the telephone rang, and she got up and answered it.
4. The man hurried down the street. He stood still for a moment while he lit a cigarette.
5. Peter was travelling round the world. He spent *a* week in Mexico because he got married there.

Part III

Translation Passages

Translation Passages

1. Architectural style

Architectural style is a way of classifying architecture largely by morphological characteristics - in terms of form, techniques, materials, etc. However, this is not a holistic way of understanding architectural works because of the emphasis on the details of style. It overlaps with, and emerges from the study of the evolution and history of architecture, but it is slightly different in its emphasis. While in architectural history, the study of Gothic architecture, for instance, would include all aspects of the cultural context that went into the design and construction of these structures.

Architectural style is a way of classifying architecture that gives emphasis to characteristic features of design, leading to a terminology such as Gothic "style". This could then be applied to buildings produced during periods outside the historic period of Gothic architecture. Thus, one could build a Gothic style church even today, irrespective of the historic period from which the style emerged.

2. Telecommunications engineering

Telecommunications engineering focuses on the transmission of information across a channel such as a coax cable, optical fibre or free space.

Transmissions across free space require information to be encoded in a carrier wave in order to shift the information to a carrier frequency suitable for transmission, this is known as modulation. Popular analog modulation techniques include amplitude modulation and frequency modulation. The choice of modulation affects the cost and performance of a system and these two factors must be balanced carefully by the engineer.

Once the transmission characteristics of a system are determined, telecommunication engineers design the transmitters and receivers needed for such systems. These two are sometimes combined to form a two-way communication device known as a transceiver. A key consideration in the design of transmitters is their power consumption as this is closely related to their signal strength. If the signal strength of a transmitter is insufficient the signal's information will be corrupted by noise.

3. Instrumentation engineering

Instrumentation engineering deals with the design of devices to measure physical quantities such as pressure, flow and temperature. The design of such instrumentation requires a good understanding of physics that often extends beyond electromagnetic theory. For example, radar guns use the Doppler effect to measure the speed of oncoming vehicles. Similarly, thermocouples use the Peltier-Seebeck effect to measure the temperature difference between two points.Often instrumentation is not used by itself, but instead as the sensors of larger electrical systems. For example, a thermocouple might be used to help ensure a furnace's temperature remains constant. For this reason, instrumentation engineering is often viewed as the counterpart of control engineering.

4. Computers

Computer engineering deals with the design of computers and computer systems. This may involve the design of new hardware, the design of PDAs or the use of computers to control an industrial plant. Computer engineers may also work on a system's software. However, the design of complex software systems is often the domain of software engineering, which is usually considered a

separate discipline. Desktop computers represent a tiny fraction of the devices a computer engineer might work on, as computer-like architectures are now found in a range of devices including video game consoles and DVD players.

Computer engineering is a discipline that combines elements of both electrical engineering and computer science. Computer engineers are electrical engineers that have additional training in the areas of software design and hardware-software integration. In turn, they focus less on power electronics and physics. Computer engineers are involved on all aspects of computing, from the design of individual microprocessors, personal computers, and supercomputers, to circuit design, as well as the integration of computer systems into other kinds of systems (a motor vehicle, for example, has a number of subsystems that are computer and digitally oriented). Common computer engineering tasks include writing embedded software for real-time microcontrollers, designing VLSI chips, working with analog sensors, designing mixed signal circuit boards, and designing operating systems. Computer engineers are also well-suited for research in the field of robotics, which relies on using computers together with other electrical systems.

5. Project Engineering

For most engineers not involved at the cutting edge of system design and development, technical work accounts for only a fraction of the work they do. A lot of time is also spent on tasks such as discussing proposals with clients, preparing budgets and determining project schedules. Many senior engineers manage a team of technicians or other engineers and for this reason project management skills are important. Most engineering projects involve some form of documentation and strong written communication skills are therefore very important.

The workplaces of electronics engineers are just as varied as the types of work they do. Electronics engineers may be found in

the pristine laboratory environment of a fabrication plant, the offices of a consulting firm or in a research laboratory. During their working life, electronics engineers may find themselves supervising a wide range of individuals including scientists, electricians, computer programmers and other engineers. Obsolescence of technical skills is a serious concern for electronics engineers. Membership and participation in technical societies, regular reviews of periodicals in the field and a habit of continued learning are therefore essential to maintaining proficiency. And these are mostly used in the field of consumer electronics products.

6. Control engineering

Control engineering has a wide range of applications from the flight and propulsion systems of commercial aeroplanes to the cruise control present in many modern cars. It also plays an important role in industrial automation.

Control engineers often utilize feedback when designing control systems. For example, in a car with cruise control the vehicle's speed is continuously monitored and fed back to the system which adjusts the engine's speed accordingly. Where there is regular feedback, control theory can be used to determine how the system responds to such feedback.

7. Aerospace engineering

Aerospace engineering is the branch of engineering that concerns aircraft, spacecraft and related topics. It is often called aeronautical engineering, particularly when referring solely to aircraft, and astronautical engineering, when referring to spacecraft.

Aerospace engineers design, develop, and test aircraft, spacecraft, and missiles and supervise the manufacture of these products. Those who work with aircraft are called aeronautical engineers, and those working specifically with spacecraft are astronautical engineers. Aerospace engineers develop new

technologies for use in aviation, defense systems, and space exploration, often specializing in areas such as structural design, guidance, navigation and control, instrumentation and communication, or production methods. They also may specialize in a particular type of aerospace product, such as commercial aircraft, military fighter jets, helicopters, spacecraft, or missiles and rockets, and may become experts in aerodynamics, thermodynamics, celestial mechanics, propulsion, acoustics, or guidance and control systems.

8. Astroengineering

Astroengineering is the construction of megastructures in space by technologically advanced beings. It is a form of megascale engineering, but deals with structures that are "easily observable" from interstellar or even intergalactic distances with 20th century astronomical instruments: i.e. An orbital elevator is an example of megascale engineering, but it is **not** an example of *astroengineering*. Typically proposed feats of *astroengineering* are on the scale to remake an entire stellar system.

Part IV

Glossary of Technical Terms

Glossary of Technical Terms

Analytic geometry: the study of geometry using algebra You'll study analytic geometry.

Descartes is the originator of analytic geometry.

This is an interesting problem in analytic geometry.

***Calculus:** a branch of higher mathematics*

Of course, you'll study calculus.

Like other branches of mathematics, calculus requires a lot of study.

The field of calculus is divided into two areas.

Chemistry: the science which deals with the composition, properties, and uses of a substance.

You'll have general chemistry.

Chemistry attracts many brilliant men.

Studies in chemistry are essential to many fields of science.

Circuit: a path over which electricity flows

You'll take courses in basic electrical circuits.

The circuits shown in this diagram is very complicated.

These are the basic laws for the study of electric circuits.

Complex variable: a variable in mathematics which has both a real and an imaginary part.

You'll have quite a variety of other courses, such as complex variables.

Problems with complex variables are often very difficult.

The theory of complex variables is used in designing electric circuits

Deformable : capable of changing shape under pressure

You'll take courses in the mechanics of deformable bodies.

A body which is not deformable is said to be rigid.

The study of deformable bodies necessarily involves higher mathematics.

differential equation: an equation involving the slight differences between consecutive values o a variable.

You'll have quite a variety of other courses, such as differential equations.

The study of differential equations consider both ordinary and partial types.

You should be able to solve this differential equation.

energy: the capacity to perform work

You'll study general physics, including energy.

How much energy is necessary to lift this body?

Power is described as the rate of change of energy.

equation: an expression of equality between two quantities, indicated by an equals sign (=)

You'll have quite a variety of other courses, such as differential equations.

This equation has two variables.

Can you express this idea in the form of an equation?

force: the cause of changes in speed of movement of bodies

You'll study general physics, including force.

Newton's laws express basic ideas about forces.

If no force is applied, the body will move at a constant speed.

Infinite series: the summation of an infinite number of terms

You'll have quite a variety of other courses, such as one in infinite series.

The concept of infinite series is essential to the solution of this equation.

What is the law that states how the infinite series is formed?

Inorganic : relating to, or composed of matter which is not animal or vegetable

You'll probably have inorganic chemistry.

The study of inorganic chemistry is usually offered during the first year.

The experiments in this series d3eal only with inorganic matter.

Matte: whatever occupies space

You'll study general physics, including properties (characteristics) of matter.

Einstein's theories are basic in our understanding of matter .

Matter is also defined as whatever communicates itself to the senses in some way.

Mechanics: the branch of physics and engineering which deals with the action of forces on bodies.

You'll take courses in the mechanics of rigid bodies.

The motion of a spinning top is a complex problem of mechanics.

Newton's laws of motion are involved in the study of mechanics.

Physics: the science that deals with the properties and changes of matter and energy, and their interaction

First, you'll study general physics.

Mechanics and thermodynamics are branches of physics.

Physics has attracted many more students in recent years.

Rigid: capable of keeping a given shape under pressure

You will take courses in the mechanics of rigid bodies.

There are many forces acting on this rigid body.

You were wrong in regarding the body as rigid.

Variable: a quantity which may have numerous different values

You'll have quite a variety of other courses, such as complex variables.

This expression gives the value of the unknown variable.

Both variables must be evaluated for the complete solution.

Vector : a quantity which has both size and direction

You'll study general physics, including vectors.

A force is a vector, whereas a mass is not.

In drawing a vector, the length of the line indicates the size.

Both force and speed can be expressed as vectors.

Compressible: capable of changes in volume under pressure.
You senior year will consists of dynamics of compressible fluids and similar courses.
Air is an example of a compressible fluid.
The material you choose must be compressible.

Conversion: a change from one form to another
In your senior year you'll study energy conversion.
The electric motor is an energy conversion machine.
Conversion is a term also used in mathematics.

Digital: dealing with digits (marks representing whole number)
In you senior year you'll have digital analysis and design.
There are many number systems used in digital analysis.
Digital computers are practical because of their high speed of operation.

Dynamics: the branch of mechanics dealing with the motion of bodies and the forces which produce the motion.
In your senior year you'll have structural dynamics
Newton's laws of motion are essential to the study of dynamics.
The motion of a swinging body is a problem in dynamics

Electric field: a space in which forces are created by electricity
Among other courses, you'll take electric fields.
A knowledge of vectors is important in the study of electric fields.
The motion of this body is due to an electric field.

Field: as used here, a space in which a force of a certain natural is active .
Among other courses, you'll take electric and magnetic fields.
The motion of this body is due to an electric field.
What is the intensity of this field?

Fluid: a substance which can flow

You'll also take courses in fluid mechanics

Both gases and liquids are classed as fluids.

A fluid tends to take the shape of its container.

Magnetic: behaving like a magnet (something that attracts iron)

In electrical engineering you'll take electric and magnetic fields.

Ampere's law is basic in the study of magnetic fields.

In this way we can change the one in magnetic force.

Magnetic field: a space in which forces are created by magnets or by moving electricity

Among other courses, you'll take magnetic fields.

This device points in the direction of the earth's magnetic field.

Ampere's work is basic in the study of magnetic fields.

Network: as used here, an electric circuit; (more generally, a combination of electric circuits)

Among other courses, you'll take network theory

A good knowledge of mathematics is necessary for the study of networks.

You can't pass the exam without some knowledge of networks.

Nuclear: forming a nucleus, a basic unit of the structure of matter.

In mechanical engineering one of your choruses will be Nuclear Reactors.

Nuclear physics has become one of the most important branches of science.

Nuclear energy is now being used in ships

Reactor: a device in which controlled nuclear energy is produced

One of your courses will be Nuclear Reactors.

A nuclear reactor is also called a pile.

The control problem in nuclear reactors is extremely important.

Surveying: the branch of civil engineering dealing with the measurement and description of pieces of land

You'll also take courses in surveying

Accurate surveying will be needed to plan this road

There are many specialties within the filed of surveying.

Thermal: having to do with heat

Your senior year will consists of thermal power and similar courses.

The thermal power here is an indication of losses.

The efficient use of thermal energy is essential in this operation.

Engineering: The application of scientific principles to practical ends. An engineer is a member of the engineering profession, though the term also refers to people who operate or maintain certain kinds of equipment- a locomotive engineer on a rail- road for example. In the latter use, the person referred to is a highly trained technician rather than a professional engineer.

Empirical Information: that is based on observation and experience rather than on theoretical knowledge.

Wedge: A triangular- shaped piece of material with one very acute angle. It is one of the simple basic machines used for tightening or levering.

Inclined plane: A surface at an angle less than 90° from the horizontal. It is another simple of basic machine used to raise or lower a load by rolling or sliding.

Quantification: Giving numerical values to information.

Horsepower: A measure used in the English- speaking countries for the work performed by a machine. It was devised in the

eighteenth century by James Watt and equals 33.000 foot-pounds per minute.

Mechanical Advantage: The ratio of the output force of a machine to the input force necessary to work the machine.

Mechanical Engineering: The branch of engineering that deals with machines and their used. Industrial engineering is a branch of this field that deals with the use of machines in industrial environments such as factories.

Civil Engineering : The branch of engineering that deals with the design and building of structures intended to be stationary-buildings, dams and bridges, for example.

Mining and Metallurgy: The branch of engineering that deals with extracting materials from the earth and refining them.

Chemical Engineering: The branch of engineering that deals with processes involving reactions among the elements, the basic natural substances. Petroleum engineering deals specifically with processes involving petroleum.

Electrical and Electronic Engineering: The branch of engineering that deals with the effects and processes resulting from the behavior of tiny particles of matter called electrons.

Aerospace Engineering: A branch of engineering that deals with flight in the earth's atmosphere or in space.

Nuclear Engineering: A modern branch of engineering that deals with the processes resulting from the break- up of some particles of matter.

Systems Engineer: An engineer who coordinates the work of other engineers from different disciplines who are involved in one project.

Profession: An occupation such as law, medicine or engineering which requires specialized education at the university level.

Beam: as used here, the horizontal support of a structure

The structural engineer will have to figure the size of beams.

The load on a beam determines its size and shape.

The stress on a beam is an important structural problem.

Civil engineer: an engineer whose specialty is the design and construction of buildings, roads, harbors, irrigation systems, and works of a similar nature.

I want to talk with you about the work of a civil engineer.

The term "civil engineer" was set up as distinction from the military engineer.

Consultant engineer: an expert in a specific field of engineering whose function is to provide professional advice and services.

A small percentage of civil engineers become consultant engineers.

It is important that a consultant engineer be familiar with modern developments.

It is often necessary for a firm to hire a consultant engineer.

Dam: a barrier across water controlling its flow

What about dams?

The strength of a dam is an important design consideration.

Dams can greatly affect wide geographical areas.

Industrial waste: material left over from industrial production

Sanitary engineering deals with industrial wastes.

Strict laws govern the handing of industrial wastes.

Industrial wastes often make our rivers impure.

Irrigation: the artificial watering of land

It includes problems in irrigation.

Irrigation plays an important role in agriculture.

Floods can sometimes be helpful to irrigation.

Sanitary engineering: a branch of civil engineering dealing with sewage and waste problems.

Another area, not so well known, is sanitary engineering

The need to control disease was one of the reasons for the development of sanitary engineering.

Sanitary engineering grew out of a combination of physical and biological sciences.

Sewage : waste matter usually disposed of by drains

Sanitary engineering deals with sewage.

The handling of sewage is important in civic planning.

Sanitary and storm sewage sometimes form two separate systems.

Strain : the change of shape or size of a body through the action of a force.

He will have to figure strains.

The strain of a body is sometimes also called the deformation.

How much strain will occur in this case?

Stress : force between touching surfaces of bodies, due to external forces

He will have to figure stresses.

The stress developed per unit of area is called unit stress.

The study of stresses is essential to an engineer.

Structure: something constructed, usually of large size, the manner of construction; the part of a construction responsible for its strength .

His job is to make sure that the structures are sound

That bridge has an impressive and beautiful structure.

The roof structure of this building is too weak.

Transportation engineering: the branch of civil engineering dealing with the design and construction of highways, railroads, airports, etc.

One of the better known areas is transportation engineering.

The design of roads is an important field of transportation engineering.
Economic and human problems are often involved in transportation engineering.

Aeronautical: having to do with aircraft

Aeronautical engineering became a very large field with the widespread use of airplanes.

The government recognized the importance of aeronautical research.

Thermodynamics is important in aeronautical design.

Air conditioning: the process of regulating the temperature, humidity, and purity air entering an enclosure.

Air conditioning relies quit a lot on thermodynamics.

Air conditioning is necessary for the operation of many laboratories.

The hot air outlets are also used for air conditioning in the summer.

Automotive: having to do with automobiles

Isn't that part of the automotive industry?

Automotive engineering has a great influence on the national economy.

The automotive engineer is always concerned with stresses and strains.

Carnot cycle: a thermodynamic cycle first described by Carnot

I've heard of the Carnot cycle.

The Carnot cycle assumes ideal conditions.

The Carnot cycle provides the greatest efficiency for turning heat into work.

Crane: a machine for raising, lowering, and shifting heavy weights

If we know the purpose of a crane, we can make the most efficient use of the materials we have.

Cranes are necessary in the construction of tall buildings.

Electrically powered cranes have found a variety of uses.

Cycle: a completed series of actions with a return to the original condition – in speaking of engines, cycle means stroke.
The mechanical engineer deals with two – and four – cycle engines.
The two – cycle engine fires once each time the engine over.
A four – cycle engine fires once every fourth stroke.

Diesel: an internal combustion engine in which the fuel ignites as a result of the high temperature of the air under pressure .
The mechanical engineer deals with diesel engines.
The fuel in a diesel engine is not ignited by a spark.
Diesel engines are often used in ships.

Heat transfer: the carrying of heat from one place to another
Refrigerating relies quite a lot on theories of heat transfer.
This machine has low heat transfer ability.
There are several heat transfer processes.

Internal combustion engine: an engine in which power is produced by the burning of a fuel – and- air mixture.
The whole field of internal combustion engine is used in almost all automobiles.
The diesel is an internal combustion engine.

Load: the amount of pressure on a structure due to weight; the outside resistance that a machine has to overcome; the outside resistance of an electric network; the amount of electric power that must be produced .
We know the loads that this machine will be subjected to.
Controlling the loads of electric power systems is a serious problem.

The amount of fuel used varies with the load against which the engine is operating.

Refrigerating: the process of lowering the temperature of air
Refrigerating relies quite a lot on thermodynamics.
refrigerating is necessary for protecting some food.
Heat losses must be avoided in refrigerating processes.

Thermodynamics: the science dealing with the relationship of mechanical work and heat
Air conditioning relies quite a lot on the thermodynamics.
The law concerning energy are important in thermodynamics.
The second law of thermodynamics is due to Carnot.

Turbine: an engine in which the power is provided by a wheel driven by the flow of steam, water, or air.
The mechanical engineer deals with gas turbines.
High temperature were a problem in the development of gas turbines.

Lever: A basic machine consisting of a rigid piece or bar that turns on a point.

Fulcrum: The point on which a lever turns.

Effort End: The point where force is applied to a lever.

Load End: The point where there is resisting force on a lever.

Wheel and Axel: A basic machine consisting of a wheel that rotates on a shaft called the axle.
Crank: A bent shaft or arm for transmitting motion or changing for rotary to reciprocation motion and vice versa.

Pulley: A basic machine consisting of a wheel with a grooved rim through which a rope, wire, or chain is passed.

Block: A pulley contained in a housing; the combination of a fixed and a movable block together with a rope is known as a block and tackle.

Wedge: A basic machine consisting of a piece of material tapering to a thin edge.

Inclined Plane: A basic machine; at its simplest a surface at an angle to the horizon.

Screw: A basic machine sometimes described as a helical inclined plane or a cylinder with a helical groove around the outer surface.

Helix: The corkscrew- shaped figure that results form wrapping the line of an inclined plane around a cylinder; the plural is helices.

Jack : A device used to raise heavy weights for short distances.

Appliance : in this sense, an electrical device, usually for household convenience .

My knowledge is pretty much limited to the appliance around our house.

Here is a list of parts for this appliance.

Thee wiring is not adequate for the appliance you plan to have.

Channel: as used here, a range of frequencies within which a station sends messages.

Channel capacity is one of the problems that come up.

A radio station operates on a given channel.

The width and position of the channel is different for each type of communications system.

Communications: as used here, the sending of messages by electrical signals.

The field of communications is a relatively recent one.

Many new communications devices have been discovered recently.

Noise is a great problem in communications.

Computer: an instrument for the s0olution of problems that can be expressed in mathematical terms.

Computers take only seconds to solve problems that would take years to solve by ordinary methods.

This computer can play chess.

Many uses for computers are found in modern industry.

electronics: the field of science dealing with devices which operate through the action of electrically charged particles, known as electrons.

More recent is the field of industrial electronics.

The progress in electronics has made radio and television possible.

Electronics: the field of science dealing with devices which operate through the action electronically charged particles , known as electrons

More recent is the field of industrial electronics

Electronics is used in may way in aviation equipment.

Frequency: the number of occurrences, or cycles, per second

There is the problem of controlling the frequency of power systems.

He is capable of hearting unusually high frequencies.

The frequency of most electric power in the United States is 60 cycles per second.

Generation : production said of electrical power the problems he deals with concern the efficient generation of electrical power.

This plant uses coal for power generation.

The generation of electric power must meet the needs of the consumers.

Modulation: variation of some characteristic of a radio wave

Modulation is only one of the problems that come up.

In frequency modulation, we vary the frequency of the radio wave.

This circuit will provide a special type of modulation.

Phase: as used here, part of a cycle, with reference to a starting point.

There is the problem of controlling the phase of power systems.

Many electrical appliances use only one phase.

The two voltages have the same phase.

Power: as used here, electrical power

To start with, there is the power engineer.

He is making a study of power system.

Power is now available in rural areas at low rates.

Solid-state: the condition of a substance in which it resists pressure and maintains it shape in contrast to gas or liquid states .

We haven't touched on solid – state engineering.

Solid – state physics has made important recent advances.

Solid- state electronics is a new field of electrical engineering.

Voltage: a unit of measure of the work done by electricity

The problems have to do with the voltage at which power must be generated.

These two point are at the same voltage.

You must compute this voltage with a voltage standard.

Wave guide: a system with material boundaries to guide radio waves.

We're using a new kind of wave guide.

Efficient transmission by wave guides has its limitations.

Many waveguides use a hollow tube.

Coal Liquefaction: A process by which a liquid fuel can be made from coal.

Coal Gasification: A process by which a fuel gas can be made from coal.

Substitute Natural Gas (SNG): A fuel gas, similar in heating value to natural gas, that can be made from coal or other materials.

Coal Conversion: Making a liquid or gaseous fuel from coal.

Oil shale: A mineral that can be processed to make a petroleum – like product; the product is called shale oil.

Zero Emission: A concept under which a plant would not emit any polluting substances whatsoever. No zero – emission plant presently exists.

Biomedical Engineering: The science that uses engineering principles to help cure or alleviate disease.

Artificial kidney: A device perfected by biomedical engineers that can keep people alive after their own kidneys have stopped working.

Technological Obsolescence: The process by which technical knowledge becomes outdated and less useful with the passage of time.

Continuing Education: Learning that is carried out from the time one leaves college to the end of one's career.

Computer Control: A way in which a computer is used to help run a process plant.

Mathematical Modeling: A way of expressing in mathematical terms what goes on in a chemical process.

Computer Simulation: The use of a mathematical model in a computer so that an engineer can discover the effect of changing variables without actual experimentation in a plant or pilot plant.

Mineral: A naturally occurring, inorganic substance, usually crystalline, with relatively definite chemical composition and physical characteristics. Although coal in its rock like form is originally organic, it is sometimes classified as a mineral.

Metal: Any one of a group of chemical elements with similar properties. Metals are usually shiny, malleable with similar hammered into sheets), and ductile (able to be pulled out into long, thin shapes). They all conduct heat and electricity and can replace hydrogen in certain compounds. Iron, copper, gold, sold, silver, and aluminum are common metals.

Crystal: A solid substance with a symmetrical, repetitive arrangement of surfaces. Quartz, a compound frequently found in rock and sand, has a crystalline structure, like a diamond.

Rock: Hard material on the outer crust of the earth consisting of one or more minerals. There are three kinds of rock: igneous (a familiar example is granite), sedimentary (a familiar example is limestone), and metamorphic (a familiar example is mrble)

Mining: The process of extracting minerals from the earth. A mine is the place where this process takes place.

Quarrying: The process of excavating rock to obtain stone usually used for building purposes. A quarry is the place where the process is carried on.

Compound: A chemical state in which two or more elements are joined together. Quartz is a compound of one particle of atom of silicon and two of oxygen; its chemical name is silicon dioxide.

Ore: A mineral compound that contains a metal or some other element that can be extracted for profit.

Alloy: A mixture rather than a compound of two or more metals. Familiar alloys are bronze (copper and tin), brass (copper and zinc), and steel (iron and carbon).

Concentration: The process of separating metal from rock in an ore.

Refining: Removing impurities from metal that has been concentrated from its ore. The entire process of extraction, concentration, and purification is often referred to as refining.

Smelting: A process for extracting or refining metal that involves heating until the metal melts.

Cassiterite: The mineral form in which tin usually occurs.

Outcrop: A rock formation exposed on the surface of the earth.

Shaft: A vertical opening into the earth. Shaft mining is underground mining.

Vein or Seam: A mineral deposit between layers of rock under the ground. Vein usually refers to a metallic ore and seam to coal.

Meteorite: A mineral mass that has entered the earth from space; it often consists of iron and nickel.

Charcoal: A nearly pure form of carbon obtained by the partial burying of wood; it burns at high heat.

Cast Iron: A form of iron that contains a relatively high percentage of carbon.

Wrought Iron: A form of iron with a lower percentage of carbon than cast iron; it is more malleable and ductile than cast iron.

Slag: Impurities separated from a metal during the smelting process.

Steel: An alloy of iron and carbon, with a carbon content of up to 1.7 percent; it is hard, tough, and easily worked.

Quenching: Plunging a hot metal into cold water, or other liquid, to harden it.

Coke: A product of coal from which gases have been removed by heating; it burns at very high heat.

Crucible Process: An eighteenth – century steelmaking process involving melting the metal at very high temperatures in clay vessels known as crucibles.

Bessemer process: A nineteenth – century steelmaking process in which a blast of air is blown through the molten (red – hot and liquid) metal in a vessel called a converter.

Electrolysis or Electrolytic process: A method of reducing ores or refining metals by passing an electric current through a liquid mixture or solution.

Geology: The study of the physical features of the earth such as rocks, mountains, and so on. A geologist is a specialist in the field of geology.

Sedimentary Rock: Rock which was formed from mud, sand, and silt (sediment) that was carried down to ancient seas by the rivers of the past. Pressure changed the sediment into rock. Petroleum is found only in areas where there is sedimentary rock.

Igneous Rock: Rock that was formed under intense heat, as in volcanic activity.

Porous: Full of tiny holes that permit the passage of air, water, or other liquids. Limestone, sandstone, and dolomite are typical porous rocks which allow oil to move through them.

Fault: A break or fracture in the layers of rock in the earth's surface, often the result of an earthquake. The shift in layers of rock can cause oil to be trapped.

Anticline: A place in the earth's surface where layers of rock have formed an arch or dome. This is another type of rock formation in which oil can be trapped.

Stratigraphic Trap: A place in the earth's surface where layers of one kind of rock come together, trapping a different kind of rock between them. This is another type of formation in which oil can be found.

Core: A sample of rocks obtained by a drill. The core can be studied for the types of rocks and for evidence of fossils.

Paleontologist: A person who has specialized in paleontology, the study of prehistoric life through the evidence of fossils.

Geophysicist: A specialist in geophysics, the science that deals with the effects of forces such as gravity or magnetism on the earth. Geophysics combines some of the disciplines of geology with those of physics.

Gravimeter: A device which can measure the pull of the earth's gravity. It can indicate what kinds of rocks may lie beneath the surface.

Magnetometer: A device which can measure te strength of the earth's magnetic field. It also indicates the kinds of rocks beneath the surface.

Seismograph: A device to measure the vibrations in the earth. It is commonly used to detect and measure earthquakes, but it can also be used to explore for oil.

Bearing: supporting
Rock will support bearing pressures up to 15 tons per square foot.
This is not a bearing wall, so it may be removed.
You can't put a door here because this is a bearing wall.

Caisson: a box into which water cannot flow, used during under – water construction.
An example of this is the open caisson.
Both open and pneumatic caissons are used To what depth will the caisson be sunk?
To what depth will the caisoon be sunk?

Cast: form by pouring into a molding
Concrete piles are either pre- cast or cast in situ.
These piles were cast three days ago.
Before the piles are cast we must have exact measurements.

Cast in situ: Cast in the place of use
Concrete piles are either pre-cast or cast in situ.
The cast in situ does not need to be reinforced.
It is cheaper to use the cast in situ.

Cofferdam: a box into which water cannot flow, used during underwater construction
An example of this is the cofferdam
The type of cofferdam used depends on local conditions.
A cofferdam must be made of impermeable materials.

Column: a slender vertical supporting member
Separate footings may be used to support columns.
The columns add beauty to the building.
There are six columns across the front.

Dock: a place where ships load and unload
It is used for large structures, such as dock walls.
Te dock will need special gates.
A fracture has developed in the dock wall.

Footing: a widening of a foundation or base to spread the weight over a larger area

A bearing wall is supported by a continuous footing.

A single footing will be satisfactory here.

The drawing indicates the size of the footing.

Foundation bed: the soil over which a foundation is built The stratum of soil on which it rests is called the foundation bed.

Rock forms an excellent foundation bed.

This soil is not satisfactory for the foundation bed.

Mat: a slab or beam which resists upward soil pressures

A mat (also called a raft) is often used.

A mat will be necessary for the foundation

The thickness of the mat has not been calculated.

Molding : as used here, a structure to old concrete in place until it has hardened.

This type is preferred because it requires no molding.

The molding is left in placed until the concrete has hardened. A special molding will be necessary here.

Open caisson: a caisson without a bottom An example of this is the open caisson. You should use concrete for the open caisson. An open caisson may be sunk only to a limited depth.

Pier: as used here, a large pile

Piers may be used to transfer the weight to stronger substrata. There will be two piers on each side. This pier reaches to an unusual depth.

Pile: a long piece of wood, steel, or concrete driven into the ground to support a load. When the surface soil is too weak, piles may be used. Piles will have to be driven into the sand. I believe this structure is going to requires piles.

Pneumatic: having to do with air or gases; using or operated by compressed air. An example of this is the pneumatic

caisson. The car has pneumatic tires. They're bringing in a pneumatic drill tomorrow.

Pneumatic caisson: a caisson with one open end, sunk with this end facing the water. An example of this is the pneumatic caisson. Air will be pumped into the pneumatic caisson. The air pressure in the pneumatic caisson is higher than at the surface of the water.

Pre-cast: cast earlier and brought to the place of use. Concrete piles are either pre-cast or cast in situ. The pre-cast piles will be driven with a steam hammer.

Raft: see mat

Sheet piling: a piling which gives lateral support to a foundation bed. An example of this is the sheet piling. The sheet piling keeps the foundation bed from spreading. Sheet piling is often made of rolled steel.

Member: one of several distinct parts of a whole. The top members of the truss are called upper chords. This member will not stand the strain which will be put on it. Have you checked the length of each of the members?

Panel point: The connection point between members of a truss. What about panel points, or something like that? The panel points have already been fastened together. The stress on this panel point is too great.

Rise: As used here, the distance between the highest point and the base of a truss. In the book I ws reading, they talk about rises. This roof must have a very high rise. The rise shown in the diagram is not the same as the actual rise.

Rivet: a metal pin with a flattened head, used to join two or more things. They're usually connected by rivets. The second head of the rivet is formed by heating or pressing. It is important to know the stresses on the rivets.

Span: as used here, the distance between the centers of support of a structure. The distance between the centers of support is called the span. This special construction will allow longer spans. The span shown on the diagram is twice that actually needed.

Tension: a stretching force. These pieces are placed under tension. The extremely high tension on this member will cause failure. You are asked to figure the tensions due to this loading.

Truss: a structure with straight pieces forming triangles to support a load. The trouble is in what I think they call trusses. It is necessary to know all the stresses which will be placed on this truss. The trusses of this bridge are rather complex.

Detection: as used here, discovering or locating an object. The detection of a ship was important. What instruments do you use for detection? Radar was used for the detection of the building.

Duplexer: as used here, a device to isolate the transmitter from the receiver during radar operation. This special device is called the duplexer. The duplexer protects the receiver during transmission. The duplexer should function very fast.

Echo: The return of a signal after it has been reflected. This is the time the echo pulse was received. The echo is used to measure the distance. How many echoes did you receive?

Indicator: as used here, a device to show a desired kind of information. There are many types of indicators. The pictures on this indicator is very clear. The ship will use two different indicators.

Plan- position- indicator: see PPI

PPI: initials for Plan- position- indicator; an instrument used in radar directly to indicate the range and direction of a target. The

PPI is very common. The PPI aboard ship was damaged. The photograph was taken of a PPI indicator.

Radar: an instrument or system that measures the distance of a target by measuring the time a radio echo takes to return to the source. Radar warns ships of floating ice. The radar on the airplane can measure its height. Radar is very useful at night.

Range: as used here, the distance between the instrument and a target, or the distance capability of a radar. It is an instrument to determine the range. The range of the ship was beyond our capabilities. The disturbance caused an error in the range.

Target: as used here, the object whose position is to be determined. The instrument determines the direction of targets. It was found that the target was moving. What do you think the target could be?

Transmitter: a device to transmit electromagnetic waves. The transmitter was sending radio wave pulses. The transmitter and the receiver have the same antenna. What is the frequency of this transmitter?

Array: as used here, a group of antennas operating as a whole. You may have to use an array of antennas. An array will give the desired properties. How many antennas will this array have?

Conical antenna: a variety of horn antenna having a conical shape. This conical antenna has two cones. The conical antenna radiates evenly. What material is used for this conical antenna?.

Directivity: the ability to exhibit a given property primarily in one direction; as used here, it refers to radiation in one direction. A very high directivity is required. This antenna has changed its directivity. Can you design an antenna with better directivity?

Helical antenna: an antenna in the form of a spiral. You may need a helical antenna. The length of this helical antenna is five times its diameter. The pattern of this helical antenna has two circles.

Horn antenna: a tubular antenna, narrower at one end than at the other. Horn antennas are used for very high frequencies. This specific radiation requires a horn antenna. This horn antenna resembles a pyramid.

Loop antenna: an antenna consisting of one or more turns of conductor all in one plane. A thin wire is used for this loop antenna. This loop antenna will be portable. I doubt if a loop antenna could be used.

Parabolic antenna: an antenna with a reflector of parabolic shape. The parabolic antenna will receive weak radiation. You should form an array of parabolic antennas. What is the pattern of the parabolic antenna?

Pattern: as used here, the distribution of radiation strength around the antenna. A specific pattern will thus be obtained. I had to calculate the pattern of the antenna. The pattern of this antenna points elsewhere.

Radiator: a body used to radiate. The term radiator is used. This radiator is used for heat. The sun is also a radiator.

Reflector: a conductor used to reflect the radiation of an antenna and increase its directivity. A reflector will be needed. The paint destroyed the properties of the reflector. The reflector will have a diameter of ten feet.

Yagi antenna: an antenna system with parallel conductors in a row. The Yagi antenna is used for television. The Yagi antenna has excellent directivity. Except for one, all other conductors in a Yagi antenna are reflectors.

Analog computer: a calculating machine in which values of actual physical variables are introduced to represent the values of the quantities to be computed; if a quantity is represented by a voltage, doubling this quantity would be achieved by doubling the voltage. Analog computers use physical variables. Use an analog computer to solve the equation. This is a portable analog computer.

Arithmetic unit: as used here, the part of the computer that does the actual arithmetical calculations. The arithmetic unit is not fast enough. The arithmetic unit is part of the computing unit. Can the arithmetic unit multiply?

Computer: a calculating machine. Can you tell me how the computer works? A slide rule is a computer. Two computers will be used to check the results.

Computing unit: as used here, the part of a computer that does the computations. The computer must have a computing unit. The computing unit uses transistors. You must check the computing unit.

Control: as used here, the part of a computer that controls the sequence and the type of operations to be performed. The control is part of the computing unit. The control needs adjustments. The control failed to function.

Control generator: as used here, a device producing signals controlling the computer operation. The control generator sensed the decoder. The control generator produced a voltage. The control generator is part of the computing unit.

Decoder: as used here, the unit of a computer which interprets the instructions. The interpretation was done at the instruction decoder. Will this decoder be adequate? This decoder cannot be used in another computer.

Digital computer: a calculating machine in which seqeucnes of whole numbers represent the values of the quantities to be

computed. A quantity may be represented by a sequence of pulses; doubling the quantity will be introduced by changing the order of the pulses in the sequence without affecting the value of the pulses. The digital computer added one million numbers on one second. A digital computer was used for this equation. This digital computer is for laboratory use.

Digits: as used here, characters or symbols used to denote a number such as the symbols 2, 5, 9 in the number 259. The digital computer uses digits. There are ten digits in the decimal system. The number 4 is written as 100 if only two kinds of digits are used.

Instruction: as used here, a specific set of directions telling the computer what operations to perform. The instructions will be stored. How many instructions will be needed? This instruction meant the end of calculations.

Memory: as used here, the part of a computer in which data and information are stored. The memory of this computer will be adequate. Place this number in the memory of the computer. The memory will use a magnetic field.

Selector: as used here, a unit determining whether data will be put into or taken out of the memory. What is the input- output selector? This is a circuit for the selector. The failure was due to the selector.

Glossary of Architecture Terms (B)

architrave 1. The lowest part of a classical entablature.
2. A molding enframing an opening such as a window.

areaway The open space between a rowhouse and the sidewalk, usually beside the stoop.

awning A projecting shading device, usually of canvas, mounted on the outside of a door or window.

baluster One of a series of short vertical posts, often ornamental, used to support a rail.

balustrade A railing composed of balusters and a top rail running along the edge of a porch, balcony, roof, or stoop.

bay A regularly repeating division of a facade, marked by fenestration.

bay window A projecting form containing windows that rises from the ground or from some other support, such as a porch roof; see also oriel.

bracket A projecting angled or curved form used as a support, found in conjunction with balconies, lintels, pediments, cornices, etc.

brick molding A milled wood trim piece covering the gap between the window frame and masonry, which can be rectilinear, curved or composite-curved.

cap flashing A waterproof sheet that seals the tops of cornices and walls.

capital The topmost member, usually decorated, of a column or pilaster.

casement A window sash that is hinged on the side.

cast iron A type of iron, mass-produced in the nineteenth century, created by pouring molten iron into a mold; used for ornament, garden furniture, and building parts.

clapboard Wood siding composed of horizontal, overlapping boards, the lower edges of which are usually thicker than the upper.

colonnade A row of regularly spaced columns supporting an entablature.

colonnette A diminutive column which is usually either short or slender.

column A vertical cylindrical support. In classical design it is composed of a base (except in the Greek Doric order), a long, gradually tapered shaft, and a capital.

console A scroll-shaped projecting bracket that supports a horizontal member.

coping A protective cap, top or cover of a wall parapet, commonly sloping to protect masonry from water.

corbel An architectural member which projects upward and outward from a wall that supports a horizontal member.

cornice A projecting molding that tops the elements to which it is attached; used especially for a roof or the crowning member of an entablature, located above the frieze.

cresting A decorative element, frequently of iron, usually located at the peak or edge of a roof.

crocket An ornamental foliate form placed at regularly spaced intervals on the slopes and edges of the spires, pinnacles, gables, and similar elements of Gothic buildings.

cupola A small dome on a base crowning a roof.

dentil A small, square, toothlike block in a series beneath a cornice.

Doric One of five classical orders, recognizable by its simple capital. The Greek Doric column has a fluted shaft and no base; the Roman Doric column may be fluted or smooth and rests on a molded base.

dormer A vertical structure, usually housing a window, that projects from a sloping roof and is covered by a separate roof structure.

double-hung A type of window with two sash, each sliding on a vertical track.

drip molding A projecting molding around the head of a door or window frame, often extended horizontally at right angles to the sides of the frame, intended to channel rain away from the opening; also called a drip lintel.

eave The overhanging edge of a roof.

egg and dart An ornamental band molding of egg forms alternating with dart forms.

elevation An exterior face of a building; also, a drawing thereof.

enframement A general term referring to any elements surrounding a window or door.

English bond A pattern of brickwork with alternate courses of headers and stretchers.

entablature In classical architecture, a major horizontal member carried by a column(s) or pilaster(s); it consists of an architrave, a frieze, and a cornice. The proportions and detailing are different for each order, and strictly prescribed.

eyebrow dormer A curved dormer with no sides, covered by a smooth protrusion from the sloping roof.

facade The main exterior face of a building, sometimes distinguished from the other faces by elaboration of architectural or ornamental details.

fanlight A semicircular or semielliptical window above a door, usually inset with radiating glazing bars.

fascia A horizontal, flat element, often combined with a cornice and architrave.

fenestration The organization and design of windows in a building.

festoon A carved ornament in the form of a band, loop, or wreath, suspended from two points; also called a "garland" or a "swag."

finial The crowning ornament of a pointed element, such as a spire.

flashing Strips of sheet metal bent to fit the angle between any two roof surfaces or between the roof and any projection, such as a chimney.

Flemish bond A pattern of brickwork in which each course consists of headers and stretchers laid alternately; each header is centered between the stretcher above and the stretcher below it.

foliate Decorative leafage, often applied to capitals or moldings.

French door, window A tall casement window that reaches to the floor, usually arranged in two leaves as a double door.

frieze 1. The middle horizontal member of a classical entablature, above the architrave and below the cornice. 2. A similar decorative band in a stringcourse, or near the top of an interior wall below the cornice.

gable The upper portion of an end wall formed by the slope of a roof.

galvanized iron Iron that has been coated with zinc to inhibit rusting.

glazing bar See mullion.

Gothic sash A window sash pattern composed of mullions that cross to form pointed arches.

grille A decorative, openwork grating, usually of iron, used to protect a window, door, or other opening.

gutter A shallow channel of metal or wood set immediately below and along the eaves of a building to catch and carry off rainwater.

header A masonry wall unit of brick which is laid so that its short end is exposed.

hood A projection that shelters an element such as a door or window.

Ionic One of the five classical orders, characterized by capitals with spiral elements called "volutes," a fasciated entablature, continuous frieze, dentils in its cornice, and by its elegant detailing.

jigsaw carving Wooden ornament cut with a thin narrow saw blade.

joist One of a series of parallel timber beams used to support floor and ceiling loads, and supported in turn by larger beams, girders, or bearing walls; the widest dimension is vertically oriented.

key A block, often used in a series, which projects beyond the edge of the enframement of an opening and is joined with the surrounding masonry. A block handled in such a manner is keyed to the masonry; see quoin.

keystone The central wedge-shaped member of a masonry arch; also used as a decorative element on arches in wood structures.

latticework Thin strips of wood arranged in a netlike grid pattern, often set diagonally.

leaded window A window composed of small panes, usually diamond-shaped or rectangular, held in place by narrow strips of cast lead.

leader A horizontal or vertical cylinder, usually made of metal, which carries water from the gutter to the ground.

lintel A horizontal structural element over an opening which carries the weight of the wall above it.

loggia 1. An arcaded or colonnaded structure, open on one or more sides, sometimes with an upper story. 2. An arcaded or colonnaded porch or gallery attached to a larger structure.

lunette A crescent-shaped or semicircular area or opening on a wall surface.

mansard A roof having a double slope on all four sides, the lower slope being much steeper. In rowhouse design, a double-sloped roof on the building front, below a flat roof.

meeting rail The rail of a double-hung window sash designed to interlock with the adjacent rail.

modillion A projecting scroll-shaped bracket or simple horizontal block arranged in series under the soffit of a cornice.

molding A decorative band of varied contour, used to trim structural members, wall planes, and openings.

mullion A vertical primary framing member that separates paired or multiple windows within a single opening.

muntin A thin framing member that separates the panes of a window sash or glazed doors.

newel The main post at the foot of a stairway or stoop.

oriel A projecting bay window carried on corbels or brackets.

Palladian window A three-part window opening with a tall, round-arched center window flanked by smaller rectangular windows and separated by posts or pilasters.

panel A portion of a flat surface recessed, or raised from the surrounding area, distinctly set off by molding or some other decorative device.

parapet A low wall that serves as a vertical barrier at the edge of a roof, terrace, or other raised area; in a exterior wall, the part entirely above the roof.

paver A block of stone used in sidewalk or areaway paving.

pediment 1. In classical architecture, the triangular space forming the gable end of a roof above the horizontal cornice. 2. An ornamental gable, usually triangular, above a door or window.

pier 1. A column designed to support concentrated load. 2. A member, usually in the form of a thickened section, which forms an integral part of a wall; usually placed at intervals along the wall to provide lateral support or to take concentrated vertical loads.

pilaster An engaged pier or pillar, often with capital and base.

pitched Sloping, especially referring to a roof.

plinth A platform base supporting a column or pilaster.

pointing, repointing The treatment of joints between bricks, stone, or other masonry components by filling with mortar; also, called tuck-pointing.

portico A small porch composed of a roof supported by columns, often found in front of a doorway.

p.s.i. Pounds per square inch, a term generally used when describing water pressure when cleaning a building.

quoin A structural form, usually of masonry, used at the corners of a building for the purpose of reinforcement, frequently imitated for decorative purposes.

relief Carved or molded ornament that projects from a flat surface.

repointing See pointing.

return The part of a molding cornice, or wall surface that changes direction, usually at a right angle, toward the building wall.

reveal The side of an opening for a door or window between the frame and the outer surface of a wall, showing the wall's thickness.

rock faced Masonry treated with a rough surface that retains or simulates the irregular texture of natural stone.

rosette A round floral ornament, usually carved or painted.

round arch A semicircular arch.

rowhouse One of a group of an unbroken line of attached houses that share common side walls, known as party walls.

rubble stone Irregularly shaped, rough-textured stone laid in an irregular manner.

rustication, rusticated Stonework composed of large blocks of masonry separated by wide, recessed joints; often imitated in other materials for decorative purposes.

sash The secondary part of a window which holds the glazing in place; may be operable or fixed; usually constructed of horizontal and vertical members; sash may be subdivided with muntins.

secondary facade The facade that does not face a public thoroughfare, mews, or court and that does not possess significant architectural features.

segmental arch An arch which is in the form of a segment of a semicircle.

semidetached A building attached to a similar one on one side but unattached on the other.

shaft The vertical segment of a column or pilaster between the base and the capital.

shed dormer A dormer window covered by a single roof slope without a gable.

shingle A unit composed of wood, cement, asphalt compound, slate, tile or the like, employed in an overlapping series to cover roofs and walls.

shouldered arch An arch composed of a square-headed lintel supported at each end by a concave corbel.

shutter dogs The metal attachments which hold shutters in an open position against the face of a building.

sidelight A vertically framed area of fixed glass, often subdivided into panes, flanking a door.

sill The horizontal member at the bottom of a window or door.

soffit The exposed underside of any architectural element, especially a roof.

spalling The chipping or erosion of masonry caused by abuse or weathering.

spandrel 1. A panel between the top of one window and the sill of another window on the story directly above it. 2. An irregular, triangular wall segment adjacent to an arched opening.

stile A main vertical member of a door or window.

stoop The steps which lead to the front door; from the Dutch "stoep."

stretcher A masonry unit or brick laid horizontally with its length parallel to the wall.

stringcourse A narrow horizontal band of masonry, extending across the facade, which can be flush or projecting, and flat surfaced, molded, or richly carved.

stucco A coating for exterior walls made from Portland cement, lime, sand, and water.

subframe A secondary frame set within a masonry opening.

sugaring A term describing the deterioration of stone caused by the breaking up or dissolving of the stone surface.

surround The ornamental frame of a door or window.

swag A carved ornament in the form of a draped cloth or a festoon of fruit or flowers.

terra cotta Hard fired clay, either glazed or unglazed, molded into ornamental elements, wall cladding and roof tiles.

tie rod A metal tension rod connecting two structural members, such as gable walls or beams, acting as a brace or reinforcement; often anchored by means of a metal plate in such forms as an "S" or a star.

tracery An ornamental configuration of curved mullions in a Gothic sash.

transom 1. A horizontal bar of wood or stone across a window. 2. The cross-bar separating a door from the window, panel, or fanlight above it. 3. The window above the transom bar of a door.

transom bar A horizontal element that subdivides an opening, usually between a door and window.

trefoil A three-lobed decorative form used in Gothic architecture

tuck-pointing See pointing.

turret A small tower, usually supported by corbels.

volute A carved spiral form in classical architecture; often used in pairs as in the capitals of Ionic columns.

voussoir A wedge-shaped component of an arch.

wrought iron Iron that is worked by being forged or hammered.